Self-corrections in oral reading

Kusters, Egidius Dominicus Maria

Publication date:
1987

Document Version
Publisher's PDF, also known as Version of record

Link to publication in Tilburg University Research Portal

Citation for published version (APA):
Kusters, E. D. M. (1987). *Self-corrections in oral reading: Some aspects of the reading process of good and poor readers*. [Doctoral Thesis, Tilburg University]. [s.n.].

SELF-CORRECTIONS IN ORAL READING
SOME ASPECTS OF THE READING PROCESS OF GOOD AND POOR READERS

E.D.M. Kusters

SELF-CORRECTIONS IN ORAL READING

SOME ASPECTS OF THE READING PROCESS OF GOOD AND POOR READERS

SELF-CORRECTIONS IN ORAL READING
SOME ASPECTS OF THE READING PROCESS OF GOOD AND POOR READERS

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Katholieke Universiteit Brabant,
op gezag van de rector magnificus,
prof. dr. R.A. de Moor,
in het openbaar te verdedigen
ten overstaan van een
door het college van decanen aangewezen commissie
in de aula van de Universiteit
op vrijdag 6 november 1987 te 14.15 uur

door

Egidius Dominicus Maria Kusters

geboren te Heerlen

druk:
Sneldruk Enschede

promotores:	Prof. dr. L.G.M. Noordman
	Prof. dr. J.J. Dumont
assistent-promotor:	Dr. W.H.J. van Bon

aan Marlie
aan mijn ouders

Acknowledgements

This thesis concludes a period of study to which various people have contributed in many ways.
I am greatly indebted to

Prof. dr. L.G.M. Noordman (University of Brabant)

Dr. W.H.J. van Bon, Prof. dr. J.J. Dumont (Department of Special Education)

Drs. J.P.M. Kerkman, Prof. dr. R. Schreuder (Interfaculty Research Unit for Language and Speech)

Ms Dr. W. Vonk, Prof. dr. W.J.M. Levelt (Max-Planck-Institut für Psycholinguistik)

G. Burnage BA, Dip DP, (Centre for Lexical Information); F. Peels, Ms S. Aal

Ms Drs. R. Verbers, Ms Drs. A. Meynders, Drs. F. Wijnen, G. Theloosen, Ms Drs. L. Schoeber (former research assistants), students and trainees

J. Wittebrood (Electronics department)

the children and teachers of

St. Augustinus School, Oss; Het Baken, Arnhem; Carolusschool, Nijmegen; De Hameland, Zevenaar; De Hoeven, Beuningen; Keizer Karel School, Nijmegen; Koekoeksnest, Druten; Mariaschool, Boven-Leeuwen; Mayella School, Nijmegen; Meginhardschool, Arnhem; Moldycke Streekschool, Molenhoek; Nutsschool, Nijmegen; Drs. J. Oud School, Tilburg; Paedologisch Instituut, Nijmegen; Roelant School, Ubbergen; Mgr. Ruttenschool, Nijmegen; De Schakel, Boxmeer; Drs. D. Schouten School, Waalwijk; De Sonnewijser, Nijmegen; Tinnegieter, Beuningen; Vredeschool, Druten; De Wingerd, Cuijk; Het Zonnelied, Druten.

Special thanks are due to Marlie.

This research was supported by a grant (56-182) from the Netherlands Organization for Pure Scientific Research (Z.W.O.) and was carried out at the Interfaculty Research Unit for Language and Speech in Nijmegen.

Contents

Chapter 1 Introduction

When children learn to read, they master a means of communication that is almost as important as the faculty of speech and the sense of hearing. Children who suffer from severe reading problems will have great emotional and social problems. For instance, these children will often have to change school in order to receive special education. The parents will have to get used to the idea that their son or daughter has a learning problem, that their child performs below standard, etc.

The present study is concerned with the child's reading behaviour from a cognitive point of view. Reading consists mainly of the processing of highly complex information by the mental language system (the parts of the brain which lead to the ability of human beings to speak, hear, read, and write). In this processing, peripheral devices such as the eyes and – when reading aloud – the ears are involved but also central cognitive devices which assign a meaning to words and which lead to comprehension. Some aspects of the reading process will be studied to investigate whether they play a role in severe reading problems. The core of the investigations will lie in the following questions: How does a reader detect and correct his or her reading errors and what special difficulties do children with severe reading problems encounter in this respect?

In developing the means to help children with reading problems, a number of different approaches can be taken. Research may be done to develop a diagnostic apparatus. Other research may aim at the development of remedial methods. These types of research have the advantage that they may possibly lead to immediately applicable results. The present study aims at extending our knowledge of the reading process and its concomitant problems. This type of research does not in general lead directly to practical applications. However, theoretical and empirical research, leading to a deeper insight into the phenomena, is the best foundation for the development of the means to treat reading problems.

In order to get a better understanding of the children's failings, it is necessary to know which processes are involved in reading and, accordingly, to have a means to determine these processes. Errors and corrections are relevant in this respect. Reading errors and self-corrections can provide insight into the language processes in reading.

The present chapter starts with a brief discussion of reading problems. This is followed by a discussion of the utility of errors and self-corrections as a means to provide insight into the human language system and reading process. In the next section some current findings are presented on the realization of self-corrections by good and poor readers. Subsequently, the main question investigated in this study is introduced. The chapter ends with a short outline of the rest of the study.

1.1 Severe reading problems

In this section severe reading problems are introduced and defined. Then criteria are given which must be employed to select clear cases of children with severe reading problems. The section is concluded with short discussions of the cause of severe reading problems, the differences between good and poor readers and subtypes of poor readers.

Normally, children learn to read in a few years. After a short period of instruction and training, they are capable of practising on their own. For about eighteen months after the initial learning stages, the main condition to ensure steady progress in developing reading skills seems to be the exposure to appropriate reading material. If the texts are not too difficult, the child will read with enthusiasm and it will learn new, difficult words and repeat familiar words.

A number of children have serious problems in learning to read. In principle this seems to be quite natural. When a group of people starts to acquire a certain type of knowledge or starts to train for a certain skill, it is to be expected that a number of them will perform rather poorly compared to the average progress made by the total group. Similarly, it may be expected that there will be some children who are extremely successful in acquiring the knowledge or skill. Such differences can partly be explained in terms of factors which influence learning in general. A person's social, physical and psychological background as well as his age and intelligence play a role in the progress he makes when something has to be learned. These characteristics form a general basis for the functioning of human beings, and problems in these respects can lead to problems in learning. Apart from these general factors which cause variation in learning progress, there are more task-specific factors which may lead to variation in learning. Important in this respect are the skills and knowledge involved in verbal behaviour, e.g. auditive discrimination abilities (e.g. Van Bon, 1985; Van Bon & Schreuder, 1986) or the capacity to reflect on language material (the word *table* is different from the object *table*, etc.). The number of children which has serious problems in learning to read is greater than may be expected on the basis of the distribution of the general factors (Dumont & Janssens, 1983).

A definition of the severe reading problems which are investigated in this study is: *the lack of progress in learning to read which is considerably greater than may be expected on the basis of the factors which influence learning abilities in general.* The term *severe reading problem* is preferred to the term *dyslexia*, because the latter has connotations of neurological causes, irréversibility etc. that need not to be true for the readers' reading problems investigated in this study. For the same reason the children will not be referred to as *dyslexics* but as *poor readers*.

The focus of this study will be on *developmental reading problems* rather than *acquired reading problems*, which are the result of brain injury, often cardiovascular accidents (e.g. by an apoplectic stroke), resulting in a number of differentiated disorders. Acquired reading problems or acquired dyslexia usually presuppose the ability to read.

What are the criteria for selecting children that clearly suffer from severe reading problems as defined before? A number of criteria play a role (Dumont et al, 1987): reading should be the main and a clear problem (two years behind); the child should have normal or above normal intelligence (these two criteria lead to a clear discrepancy between general learning conditions and actual progress in learning to read); the reading problem should not be due to clearly physical, emotional, or social problems, nor to educational deprivation; there should be a slow development in early years in the language acquisition that leads to low scores at language tests (Van Bon, 1984), to low scores on the verbal factors of intelligence tests but to normal or high scores on nonverbal factors.

In this study it was decided to select children of about 10 years old. The children had to have a certain minimum age for two reasons: first, it should be possible to select poor readers on the basis of "being behind" and second, their mental development should be sufficient to guarantee that the experimental tasks could be carried out properly (like understanding a story of moderate complexity). The poor readers selected in this study can be characterized in terms of a stage of reading development as it was done by Van der Leij (1983, 1985): the children are able to read words of a very limited size and limited degree of morphological complexity. Only a few words are decoded automatically and fast. The rest of the words are decoded using slow strategies like pronouncing letter by letter or by guessing on the basis of the context. In the normal development of reading skills this stage is reached after one year (e.g. a reading test such as the *Een-Minuut-Test* [One-Minute Test], Brus & Voeten [1973], will lead to a score between 15 and 30. In this test the number of words read correctly from a list of increasing difficulty within one minute is counted).

What is wrong with poor readers and what is the cause of their problems? One of the earliest hypotheses about the problems in the information processing system stems from Orton (1925, 1937, quoted in Geschwind, 1982; Perfetti, 1985): the dyslexic individual has an anomalous cerebral organization. Orton was the first to recognize that the problem of dyslexia was a common cause of failure in the course of early education. He investigated the relation of dyslexia with ambidexterity and left-handedness, the high rate of reading disorders within families of dyslexics, and the frequency of slowness in the acquisition of spoken speech in dyslexic children. These relations all point in the direction of a neurological basis of severe reading problems. Whether all poor readers have a structural disorder in the brain (Galaburda & Kemper, 1979) based on a genetic predisposition is not clear yet.

Much research has so far been done to discover precisely what problems in the information system lead to reading problems. For instance, the observation that poor readers make letter reversals in reading (e.g. reading *d* for *b*) or change the order of the letters in a word, may be explained by problems in processing visual information, but also by problems in the processes that lead to lexical access (e.g. reading 'the child *babbles*' for 'the child *dabbles*' could be caused by an error within the mental lexicon). However, it is as yet not clear what is wrong with the information processing system of a poor reader or what is the cause for this malfunctioning.

Several aspects of the information processing system of good and poor readers have been compared to find differences that offer an explanation for the poor readers' reading problem. If a clear difference could be found with respect to a particular process or skill involved in reading, this could be interpreted as a deficit which may provide information about the causes of and remedies for reading problems. An immense number of skills and processes must work properly to ensure that no reading problems occur (Dumont, 1984, for example, enumerates a large number of potential trouble spots). Surveys of research in this field (e.g. Mitchel, 1982, chapter 7; Perfetti, 1985, chapter 9; Vellutino, 1979) show that differences between good and poor readers can been found for nearly all processes which may play a role in reading. However, most of these findings are only of marginal interest for drawing inferences about important sources of reading difficulties. What is it that renders most of the differences between good and poor readers of minor interest for the explanation of severe reading problems? First, some of the differences found occur only rarely. For example, there are some cases of reading difficulties that can be traced back to difficulties in oculomotor control (e.g. Pirozzolo & Rayner, 1978). The eye movements of poor readers are different from those of good readers. The differences in mean values for fixation duration, saccade length, and frequency of regressions when reading have been known for some time. But most of the researchers argue that the erratic eye movements of poor readers do not cause reading disability. Rather, they are a reflection of other underlying problems. Erratic eye movements of poor readers – sometimes even observed in a nonreading task as in the "lights test" of Pavlidis (1981, 1986) – are probably best accounted for by underlying perceptual and cognitive deficits. Pavlidis (1981, 1986) suggests that a visual-spatial deficit can cause erratic eye movements and reading problems. However, a number of researchers failed to find specific patterns in eye movements when performing a nonreading visual search task (e.g. Brown et al., 1983; Olson, Kliegl, & Davidson, 1983; Stanley, Smith, & Howell, 1983) and Rayner (1986) claims that only a small subset of the poor readers shows these problems.

Second, there are differences which may be the result rather than the cause of reading difficulties. A direct consequence of reading problems is that changes which normally take place in the course of reading acquisition will not occur. There is evidence that knowledge of orthographic rules increases with experience (Lefton, Spragins, & Byrnes, 1973); that the speed and accuracy with which unfamiliar words or strings of letters are pronounced improves (Venezky, 1974) and that the use of the syntactic and semantic context to facilitate word recognition can be used more efficiently by the more experienced reader (Klein, Klein, & Bertino, 1974). Differences between good and poor readers with respect to these skills may be the result rather than the cause of reading problems.

Third, many differences that are found in experiments may be explained by the difference between good and poor readers in their ability to name stimuli. Numerous studies have shown a difference in the visual processing skills between good and poor readers. Spring (1971), for instance, found that poor readers take longer to match pairs of simultaneously presented letters than good readers do, suggesting that poor readers suffer from a visual deficiency. The main objection that can be made is that the experimental tasks involved the use of a labelling strategy. Studies that are based on the use of stimulus materials that are difficult to label and in which stimuli have to be retained for only a very limited period (also to prevent the need for coding strategies) almost invariably show that there is no kind of visual deficiency. One example of this type of study is provided by Vellutino and his colleagues. Using Hebrew letters as stimulus material Vellutino, Steger, DeSetto, and Phillips (1975) showed that good and poor readers were equally good at selecting a given short target string out of 20 alternative items. The same argument can be made with respect to the studies that showed a difference in visual memory (e.g. Guthrie & Goldberg, 1972) or a deficiency of poor readers in remembering the order of shapes and patterns in the visual memory (e.g. Vernon, 1971). Again, when coding strategies were eliminated by the use of unfamiliar objects these differences disappeared. For example, Bakker (1967) found a difference between good and poor readers in their ability to remember the order of familiar objects, digits and letters, but no difference was found when the order of nonsense shapes had to be given.

The conclusion must be that although good and poor readers show various differences in visual, verbal and even acoustic processing, it is not clear which problems in the poor readers' information system are important for the explanation of severe reading problems. However, there is a consensus that the real problems must be located in the language coding skills rather than in the more peripheral processes such as those having to do with processing visual information as such (Bouma & Legein, 1980).

There may be various types of deficiencies in the mental language system that lead to different severe reading problems. The significance of several processes involved in reading problems is indeed often clearly illustrated by acquired dyslexics' reading problems. In a number of cases their reading abilities are only partly impaired. Marshall and Newcombe (1973) describe a patient with a disorder they call *surface dyslexia*. This patient seems to recognize written words via a phonological decoding strategy (as indicated by the many phonological errors) and appears to be unable to recognize words directly from the letters. On the other hand there are patients – who may be said to suffer from *deep dyslexia* – who are unable to follow a phonological decoding route (Coltheart, Patterson, & Marshall, 1980).

As can be inferred from the problems of acquired dyslexics there may be a number of causes responsible for severe reading problems. The assumption that there is no single cause for *severe reading problems* "has a strong common sense appeal" (Perfetti, 1985, p. 184). This leads to the assumption that there are subtypes of poor readers based on differences in the mental language system. A well-known proposal for classifying poor readers is that of Boder (1971, 1973). Boder distinguished *dysphonetics* (having a disability in phonetic processes), *dyseidetics* (having a disability in holistic visual processes) and combined dysphonetic and dyseidetic cases. Other classifications are based on patterns of hemispheric specialization (e.g. Bakker, 1979). However, the classifications that have been developed so far either lead to a division in which the majority of the poor readers belongs to one group (e.g. those children that show difficulties of left-hemisphere functioning) or to a division into groups that is mainly based on preferred reading strategy instead of a division based on differences in the mental language system (see for instance the research by Van den Bos, 1984). Subtypes of poor readers will not play a role in the present study.

1.2 Errors in language processing

The reading behaviour of poor readers will in this study be investigated by means of errors and self-corrections. What is the use of errors for the study of language behaviour? Errors or slips of the tongue – whether they be "Freudian" or not (Freud, 1966) – can be employed by linguists or psychologists as "windows into the mind" (Fromkin, 1980; p. 2). Spontaneous speech often contains indications of problems on the speaker's part. Inappropriate pauses, stutters, repetitions, errors and self-corrections mark instances of difficulties in planning and producing language (Clark & Clark, 1977). These phenomena are not random but occur according to constraints. For example, Wells (1973) formulated the rule that an error always consists of a phonologically possible sequence. From these constraints it can be inferred what linguistic units play a role in the production of language by studying what units are omitted, substituted, added, or moved in errors (e.g. Fromkin

1970). Furthermore, it is possible to investigate what autonomous processes there are in the production of language (e.g. Garrett, 1975, 1976, 1980; Shattuck-Hufnagel, 1979).

Reading errors are often studied in order to gain insight into the strategies that readers employ. The difference in reading behaviour between children who have difficulties in learning how to read and those who do not is often investigated by adopting the idea that correct features of errors can be seen as reflecting the kinds of information that a reader regularly utilizes to identify words.

What will be the role of errors in the present study? How and why errors occur in the reading processes will not be investigated. Rather, the errors are investigated in relation to self-correction behaviour: what properties of reading errors lead to correction? This should lead to insight in the linguistic knowledge that can be employed in reading by poor readers.

1.3 Self-corrections in language processing

A lot of speech errors and reading errors are spontaneously corrected by the speaker or reader. According to Levelt (1983), such a correction typically consists of three parts: the ***original utterance***, the ***editing phase***, and the ***repair***. A more detailed structure of a speech error and correction is presented in Figure 1.1.

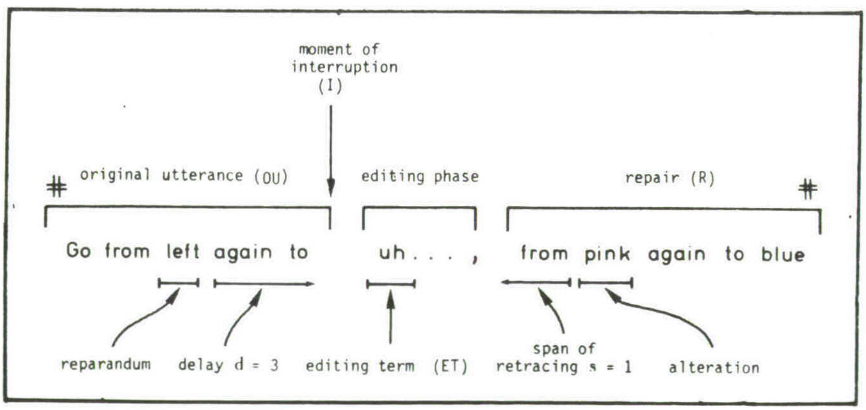

Figure 1.1 The structure of a self-correction. From W.J.M. Levelt: Monitoring and self-repair in speech. *Cognition, 14*, 1983, p. 45. (Reprinted with permission.)

The *original utterance* which contains the *error* or *reparandum* 'left' is 'Go from left again to'. It is defined to range from the last sentence boundary before the error to the *moment of interruption* (after pronouncing 'to'). The number of syllables pronounced after the reparandum is called the *delay* of interruption. The editing phase ('uh ...') may consist of a pause and *editing terms* such as 'uh'. The *repair* ('from pink to blue') contains at least one *alteration* with respect to the original utterance ('pink'). The number of syllables a speaker restarts before the reparandum in realizing the repair is called the *span of retracing* (in the example in Figure 1.1 this number is one). There is one important difference between the repair of a reading error and that of a speech error: the target sentence. In reading it is always clear which target sentence serves as the model, and hence what may be considered erroneous and has to be corrected. Consequently, in this study the *reparandum* is called an *error* and the *alteration* is called a *correction*.

When an error is corrected, something in the difference between the error and the correct form induced the speaker to stop the flow of speech and to restart in order to change the utterance produced so far. In other words the deviation between the error and the target forms the information to detect the error. Reading errors, like speech errors, can vary to a great extent when compared to the target version. It is possible to distinguish a great variety of types of errors in terms of different sorts of linguistic information. This can be illustrated by a comparison of the errors (1.1) and (1.2). (In this study a reading error normally consists of two parts: the T<arget> sentence and the R<ealized> sentence. The English translations are labeled: ET and ER).

(1.1) Partly incorrect meaning; correct word class
T (...), zeiden ze aan het eind van de vierde *oktober* toen ze gingen slapen.
R (...), zeiden ze aan het eind van de vierde *november* toen ze gingen slapen.
ET (...), they said at the end of the fourth of *October* when they went to bed.
ER (...), they said at the end of the fourth of *November* when they went to bed.

(1.2) Incorrect meaning and word class
T 'Dierendag?' zei de boer toen het de *vierde* oktober was, (...)
R 'Dierendag?' zei de boer toen het de *verder* oktober was, (...)
ET 'Animal day?' said the farmer on the *fourth* of October, (...)
ER 'Animal day?' said the farmer on the *further* of October, (...)

In error (1.1) one word is partly misread. The word class is correct; the meaning is partly incorrect. In (1.2) one word is also partly misread; the meaning, however, is completely incorrect. Also, there is a word class error and hence the syntactic structure of the complete sentence is realized incorrectly in (1.2). The information which can be used to detect error (1.1) differs drastically from that in error (1.2). By studying the difference in the number of corrections made for errors of type (1.1) and (1.2), along with a number of other types of errors, it is possible to draw inferences about the information used to correct errors.

1.4 Good and poor readers' errors and self-corrections

There are two reasons for studying self-corrections if one wants to investigate the differences between good and poor readers. Self-corrections play an important role in learning to read. Furthermore, they may provide insight into the mental language system.

When a child learns to read, only a small portion of his exercises may be subject to external feedback by a teacher, parent or other experienced reader. So, after a short period of instruction most children start to practise without the explicit help of an adult. Clearly, little progress would be made if errors were not detected. One of the differences between good and poor readers could then be a difference in correction behaviour.

Apart from the role of self-corrections in the acquisition of reading, self-corrections also provide insight into the children's mental language system as has been argued. A number of different types of linguistic information can be used for correcting a reading error. A characterization of the kind of errors that are corrected and that are not corrected probably will give information about the kind of linguistic information that is available to the reader. Differences in the correction behaviour of good and poor readers may reflect differences in the underlying language processes.

There are not many studies which aim at an analysis of errors in order to find *systematic differences* between *good and poor readers*. Even fewer studies aim at an analysis of self-correction behaviour. And most studies of that kind are based on a different group of readers from the one investigated in the present study. However, there are some studies of reading errors and corrections that are relevant here. Their subjects would fall within the group of good readers in the present study. Weber (1970b) studied the correction behaviour of children in a first-grade classroom. The class was divided into high and low achievers. High achievers corrected errors that did not fit the structure of the written sentence far more frequently than acceptable errors, while the slower readers showed no corresponding difference in their corrections. Beebe (1980) found that the percentage of acceptable errors a child produces and the percentage of corrections that are realized, form good predictors for reading comprehension and retelling scores. Paris and Myers (1981) showed that good and poor readers differ in correction behaviour when reading, but also when monitoring for anomalies formulated by somebody else. For the present study the most interesting finding is that low achieving readers correct only a few errors (Au, 1977; Allen, 1976; Clay, 1968; Weber, 1970b). It may be concluded that there is a strong relation between reading progress and correction behaviour.

Another interesting type of research in the field of reading errors is that of the so-called miscue analysis. Miscue analysis aims at identifying and evaluating the strategies that are used by readers to process written material. K. Goodman (1969, 1973) and his colleagues (e.g. Allen & Watson, 1976) call reading errors "miscues" in order to express that reading is a psycholinguistic activity in which information is processed on the basis of several types of "cues" offered by the printed material and the language. Analysis of what cues are mis-used and what cues are used correctly is directly interpreted in terms of linguistic information that is used by a particular reader.

A number of miscue pattern trends or error properties can be distinguished on the basis of the work in the field of miscue analysis (Wixson, 1979). Reading errors are often contextually acceptable rather than graphophonically similar to the original text. Errors tend to be syntactically rather than semantically acceptable. The proportion of semantically or syntactically acceptable errors and the graphic similarity between error and the written text seem to be related to age and proficiency (Biemiller, 1970; Weber, 1970a).

A real problem for the interpretation of miscues or errors is formulated by Wixson (1979): the proportion of patterns that are found vary as a function of quite a number of factors like instructional method, teacher feedback during reading, the readers' skills and backgrounds, the nature of the written material and a number of conditions surrounding its presentation (e.g. the purpose for which a text has to be read).

1.5 The main question

To get an insight into the severe reading problems of poor readers one aspect of the reading process will be investigated in this study: self-correction behaviour. The main question is: In what respect(s) do poor readers differ from good readers in their self-correction behaviour?

To answer this question it is useful to construct a priori a model of self-correction behaviour in reading. It should explain, first, how errors are detected when reading and, second, what actions follow the detection of an error in order to create a correct version. It should specify what information is used to detect errors and how different sources of information interact when they are used to detect errors. Moreover, the temporal organization of the processes involved in error detection should be characterized. Subsequently, this model has to be tested empirically.

The more detailed the picture of error detection behaviour in reading, the more specifically the differences and the similarities between good and poor readers can be investigated.

The questions and hypotheses that will be investigated are always twofold: one part is about self-correction behaviour, the other about the differences in this respect between good and poor readers (e.g. Does the syntactic structure play a role in the detection of errors? and Is there a difference in this respect between good and poor readers?).

One remark should be made on the type of research that is involved in this study. The study of speech errors is usually based on naturalistic collections of spontaneously occurring speech errors (e.g. Dell, 1980; many studies in Fromkin, 1973 and in Fromkin 1980; Garrett, 1975; MacKay, 1972; Meringer, 1908; Meringer & Mayer 1895). More recently, slips of the tongue or speech errors have been elicited in laboratory situations (e.g. Baars & Motley, 1974, 1976, etc.; Kempff, Kerkman, & Kusters 1979; Mackay, 1971). The same holds for the study of self-corrections in speech (e.g. Levelt, 1983, is a naturalistic study; Van Wijk, 1987, is an experimental study). In the present study both approaches will be employed with respect to *corrections* of reading errors. A naturalistic approach can be used to explore a phenomenon and may then be followed by experimental studies in order to test and refine a theory about the phenomenon. This will be the order of events in the present study.

1.6 Short outline

The present study consists of two parts. In the first part a model of self-correction behaviour will be developed and tested on the basis of an investigation of a collection of reading errors and self-corrections. Investigation will be made into what features of errors lead to an increased chance of detection and whether there is a difference in this respect between good and poor readers. Furthermore, the connection between error type and the structure of the self-correction will be investigated.

In the second part self-correction behaviour will be studied, using experimental techniques. In this part investigation will be carried out to discover whether correction behaviour is sensitive to the coherence of the reading material. The emphasis will be in particular on the use of some syntactic and semantic context information in error detection. Subsequently, the amount of time needed by good and poor readers to detect different types of errors will be measured.

Part I

A collection of reading errors and self-corrections

Chapter 2 Error detection in reading aloud

This chapter discusses how errors are detected when reading aloud. It begins with two general introductions, concerning models of reading and theories of speech error correction. Knowledge of the reading process is necessary to decide which monitoring activities are possible and useful at what points when reading aloud. Current theories about the correction of speech errors are discussed since they will be partly adopted to develop a model for the correction of reading errors.

These introductions are followed by the discussion of the model of error detection that is tested in this study. It is based on local monitoring activities by means of three error detection mechanisms. Subsequently, a detailed modular diagram of the mental language system is presented to illuminate how errors can be detected in various places in the system when reading aloud.

The chapter is concluded with an outline of how the main claims with respect to the model can be verified by an analysis of the correction of several types of errors.

2.1 Reading models

Reading is a complicated activity in which various kinds of linguistic units play a role. Besides letters, higher order units such as morphemes, words and constituents are involved. This was already clear from the earliest experiments that were carried out to investigate the nature of reading (Huy, 1908). The tachistocopic recognition experiments (Reicher, 1969) showed a 'word superiority effect': letters in words are identified more accurately than those presented in random strings or even individually. On the basis of this type of experiment a number of psycholinguistic models for the recognition of words have been developed in recent years. The models that considered reading as essentially the same process as listening preceded by a little extra step have been abandoned. In these *phonological recoding models* (e.g. Gough, 1972; Rubinstein, Lewis, & Rubinstein, 1971; Spoehr & Smith, 1973) the meaning of a word is accessed by a mental recoding of the letters into a phonological representation. This representation is subsequently processed as if the input consisted of sounds. However, it is now generally accepted that visual codes have direct access to word meanings, independent of phonological recoding (e.g. Barron & Baron, 1977; Bauer & Stanovich, 1980; Coltheart, 1978; Stanovich & Bauer, 1978). Yet, it still remains unclear what exact role these two types of information play in the recognition of a printed word.

According to Carr and Pollatsek (1985) two classes of word recognition models can be distinguished: the *lexical instance models* and the *parallel coding system models*. The first type of model is based mainly on an advanced structure of internal word representations (the lexicon) that may be activated by an input from the visual stimulus. To recognize a word it is not always necessary that a conversion of letters into phonemes be carried out. Within the class of *lexical instance models* it is possible to distinguish three sub-classes: *activation models*, *lexical search models*, and *verification models*. Models of the first sub-class are Morton's (1969) *logogen* model, Glushko's (1979) *activation-synthesis* model and the *interactive activation* model of McClelland and Rumelhart (1981). In these models the mental lexicon is considered to be fully engaged in the search for every word by parallel access to the entire body of members simultaneously. Models in which one candidate is retrieved from the mental lexicon through serial matching of sensory input against the members of a list of words are Foster's (1976, 1979) and Taft's (1979) *lexical search* models. Carr and Pollatsek (1985) distinguish a third subclass of lexical instance models: the so-called *verification models* (Becker, 1976; Becker, 1980; Paap, Newsome, McDonald, & Schvaneveldt, 1982). In these models several types of information (e.g. sensory input and context information) are employed for the mutual verification of the lexical selections that are based on the individual types of information.

In the *parallel coding system models* there is *a rule-based phonological recoder* alongside a visually accessible lexicon. A systematic conversion of letters into phonemes is supposed to be carried out for every word, irrespective of whether words can be recognized directly on the basis of the letters. This combination of mechanisms is intended to take maximal advantage of the total resources available for the task of recognizing various types of words (e.g. very familiar words versus very unfamiliar words). Models of this type have been suggested by Carr, Davidson, and Hawkins (1978); Coltheart, Davelaar, Jonassen, and Besner (1977) and Seidenberg (1985).

It is not the purpose of this study to evaluate the various reading models. What is important is that most of these models adopt the idea of parallel processing of information (both between mechanisms as in the *parallel coding systems models* and within one mechanism as in the lexicon of the *logogen system*). Furthermore it is generally accepted that reading is a complicated process where some initial activities may produce intermediate results which can in turn serve as the input for subsequent processes (e.g. morphological decomposition of words before access is gained to the lexicon). Both ideas are basic conditions for the hypotheses about the detection of errors that will be investigated in this study.

What happens after the recognition of a word? Its meaning has to be related to the meaning of previous words, sentences and text parts. A reader has to decide what the incoming *new* information has to do with already *given* information (Clark & Haviland, 1977). This relation can be very clear in that a word may have appeared already, but more difficult to establish if the antecedent is referred to with different words or in a different way. If a relation has to be established with an antecedent that occurred earlier in the text this may cost extra processing effort and time to reinstate the antecedent (Kintch & Van Dijk, 1978; Lesgold, Roth & Curtis, 1979) and make a connection.

If a connection has to be made with an object or proposition that is not explicitly mentioned in the text, the correct antecedent has to be inferred (Just & Carpenter, 1978; Noordman, 1979). In this case the understanding is based on the encyclopedic knowledge one has about the world. An example of a sequence of sentences which can be understood by a normal reader but only after making various inferences would be: "Good readers produce many grammatically correct errors. Poor readers do not. Their reading is more bottom-up oriented." A normal reader will not conclude that good readers produce more errors than poor readers. On the contrary, he will start from the assumption that poor readers make more errors than good readers. Furthermore he may conclude that a bottom-up reading strategy will lead to errors that are grammatically unacceptable, whereas a top-down strategy – more readily employed by good readers – will lead to grammatically acceptable errors. Possibly, he could even conclude that a top-down strategy is preferable since it is the strategy of good readers. In the same way he may conclude that producing errors that are grammatically correct is more harmless than making errors which do not fit the context. It should be clear that if reading is defined as understanding a text, a lot of activities follow after the recognition of individual words.

A theory of reading has to explain how all the elements of a text are related to a coherent representation (Noordman & Vonk, 1981). It will have to account for all the factors that may influence the processing of the text: the frequency and structure of individual words, the syntactic and semantic relations between groups of words, the relation between these groups and the rest of the sentence and the text, the complete structure of sentences, the relations between sentences or clauses, paragraphs, chapters and all other kinds of informational units that can be distinguished. Models in which a number of these factors play a role are formulated amongst others by Kintsch and Van Dijk (1978) and by Just and Carpenter (1980, see also Thibadeau, Just and Carpenter, 1982; Just & Carpenter 1987). Such a theory should also account for the problems that may occur in the construction of a coherent text representation. A reader normally has to believe that the writer of a text has tried to produce a coherent text (Grice, 1967).

For the correction of errors it is important that higher order information such as meaning and syntactic structure is constructed during reading. If coherent structures are not recognized, this may be an indication that an error has occurred.

2.2 Theories of error detection in speech

Speakers often stop their flow of speech to correct the errors they made a short moment before. How do they manage to find errors in their own speech? What information may be used and what devices must be present in the language system to make the detection of speech errors possible?

As argued by Levelt (1983) two different ways to detect speech errors may be conceived. The first one is described in the *production theory of monitoring* and the second one in the *perceptual theory of monitoring*. The first one, the production theory of monitoring (cf. Laver, 1980), presupposes control activities in particular processes involved in the production of language. If trouble is detected in one of the processes, an alarm signal may result and the speaker may stop to resolve the problem. In studying the detection of errors in the productional stage an interpretational problem is always present; every act of overt correctional behaviour can always be attributed to perceptual processes. Moreover, if corrections take place in the productional stage they are realized before anything is uttered. Most evidence for 'editorial processes', that are supposed to take place before pronunciation, is presented by Motley and Baars (e.g. Baars, 1980; Motley & Baars 1975b, 1976, 1979). In their study of experimentally elicited errors (Motley & Baars, 1975a) they demonstrate that not all possible types of speech errors are produced with equal probability and they conclude from that that there must be some pre-articulatory 'editing'. However, it is not clear whether these 'editing activities' take place on intermediate results or on an analysis of the 'inner speech'.

The second theory, the perceptual theory of monitoring, states that only the final output of the production processes is subject to error detection by parsing this output in the same manner as is performed in the comprehension of normal speech. In this theory error detection does not play a role in the production processes and therefore cannot slow down the speed of these processes. Furthermore, the devices assumed to be necessary to detect the errors are supposed to be identical to those already necessary for speech comprehension (cf. Garrett, 1980; Hockett, 1973; Hoenkamp, 1980; Laver, 1973; and Levelt, 1983).

The perceptual theory of monitoring satifies two criteria which usually play a major role in the evaluation of models of speech error detection: the speed of language processing should be influenced as little as possible by the error detection activities and, second, the error detection activities should be performed with as few extra mental devices as possible. However, a third criterion is considered in the present study: information available to detect errors should be used as much and as soon as possible. This will lead to a different evaluation of the theories of error monitoring.

If error detection is restricted to one or maximally a few points in the processing of language as is the case in the perception theory, much information to detect errors will not be accessible. If the error detection is only performed by comparing the parsed message to the intended message, there is no information available concerning inputs or outputs of intermediate processes such as word class, word meaning, phonemes, their distinctive features (Cole, 1973), etc. An error detection mechanism that has access to intermediate processes, so that all information is available to detect errors, is likely to be more efficient. Moreover, as far as the detection of errors is concerned speed seems to be gained; trouble is noticed on the spot.

One may object that the presence of a detection mechanism in all or at least most of the processes involved in the mental language system slows down the performance of this system – but if the activity of comparing the results of a particular process to certain standards is carried out parallel to the other processes, no time is lost and the performance of the system is not impaired. Another objection might be that it is unlikely that every process involved in the language system is dependent on central control or even accessible to the attention. However, the detection of trouble in one of the processes may be signalled to a device which may be called the central *process monitor* which then forms an interface between the language system and attentional processes. So the detection of an error in a process does not mean that the attention is directed to the process in question, but only that attention is required when an error occurred. In this case an action will be performed such as redirecting the eyes to a particular word which has been read before. This position is still in line with the findings of Nisbett and Wilson (1977), who claim that only the end products of cognitive operations are accessible to the attention, and not the processes involved in these operations.

In this study it is assumed that the objections against a productional theory of error detection (loss of speed and autonomy of individual processes) are invalid, whereas the loss of information to detect errors that must be assumed in the perceptual theory of error detection is disadvantageous.

2.3 Error detection in reading

At first sight there seems to be a lot of information which a reader can use in evaluating what he reads. Errors can be detected by asking questions such as: Am I reading normal words? Does what I am reading make sense? Am I making grammatical errors? Is what I read written on the paper? A negative answer to one or more of these questions indicates that an error has occurred. To obtain answers, many complicated processes of a very diverse nature seem to be involved. One process is required to decide whether a word is in the lexicon, another to decide whether an utterance is grammatical and so on. To use all the information available it seems necessary to have a control mechanism which is at least as complex as the language system itself. However, it is unlikely that a control mechanism exists which is at least as complex as the process it monitors.

The detection of a reading error is in the first place based on an evaluation of the sounds that are produced and the letters that form the input. A straightforward way of checking the reading product is to compare the sounds produced with the letters that should be vocalized, to compare the meaning of the words constituted by the sounds to the meaning of the words constituted by the letters on the paper, to compare the word class of the two words etc. There is, however, one problem with the assumption that errors may be detected by comparing the realized linguistic units with the target ones: the reader does not know what he should have realized, otherwise he would not have produced the error in the first place.

In order to describe how reading errors are corrected, a model for error detection will be formulated. In this model answers should be given to two questions: how is it possible that errors are detected by using various sources of complicated linguistic information without assuming that this is accomplished by a very complicated process? And second, how is a comparison made between what is actually read and the target without the latter being known? The model should therefore specify how some simple processes or mechanisms are capable of handling all kinds of information. Furthermore, the model should specify what information is available for error detection.

In this study it is assumed that every process involved in the language system performs its own basic control activities. Moreover, a device to control the complete language system, called the *process monitor*, is postulated. This position fits within the production theory of monitoring rather than the perceptual theory of monitoring. The complete model is based on a few assumptions concerning the processes involved in the production and perception of language. These processes can be seen as black boxes which operate on a given type of information and produce different information. It is not possible to detect errors by comparing the input with the output of the processes. The input and output are different, otherwise the process would have done nothing. To decide whether the process has worked properly, two tests are possible. First, checking whether there is any output at all. Second, executing the process twice in order to test whether the results are identical. For convenience, these two control possibilities will be called the *single output test* and *double output test*.

The use of the *single output test* as a means of detecting errors seems to be quite natural. The constraint that a process, when it receives an input should inevitably produce some output does not restrict the types of possible outcome of the process in any way. All kinds of output, including an empty one to permit for instance transformations in which elements disappear, are possible under this constraint. Everything is permitted as long as there is some kind of output. If no result can be obtained, this is signalled to the central process called the *process monitor*. Error detection that is based on the *single output test* will be referred to in the rest of this study as the *no result error detection*.

Apart from the *no result error detection* mechanism there is no other simple way to discover that a process resulted in an erroneous product. Other checks on the output should be performed by something which is similar in complexity to the process that gave the output. The decision whether an output belongs to the (sometimes infinitely great) set of possible outcomes can only be made if that set is available. It seems safe to assume that such a set is defined very efficiently by the process which produces such types of output.

The *double output test* does not seem very natural. It seems odd to execute a process twice for control reasons only. However, if the second execution of a process is performed parallel to the normal functioning of that process, this type of control would be more plausible. Moreover, the *double output test* would also work if the intermediate products that should match were to be produced by different processes. A number of possibilities will now be discussed as to how the same intermediate products can be produced more than once at low "costs" in the mental language system. A distinction will be made between products produced more than once by double execution of the same process and those produced more than once by the execution of different processes. Error detection on the basis of the *double output test* which is achieved by the execution of the same processes more than once will be called the *double way error detection*. Error detection by matching output from different processes may be called *two way error detection*.

In reading aloud the *double way error detection* may be based on the double decoding activity of a reader: he decodes and interprets the input consisting of letters and, second, he decodes and interprets his own reading aloud. Both activities can be carried out in parallel and fairly autonomously. A number of intermediate results should be equal, such as the word class and the meaning of words.

In reading aloud, the *two way error detection* is possible based on redundant processing. In a complicated system it might be useful to have more processes which produce the same output via different mechanisms to gain speed (race model). This can easily be demonstrated by an example of simple arithmetic. If one has to divide 12 by 3 the result will be obtained very fast when the division is done mentally and only moderately fast if it is done with a pocket calculator. If, on the other hand, the division was 1747.388 divided by 436.847 the same result would probably be obtained fastest by using the pocket calculator. The fastest result is obtained if for every division one person starts to divide mentally while another person starts to divide with a pocket calculator. The same holds for psycholinguistic processes. If the meaning of *boy* has to be inferred on the basis of a letter input one option is to look it up in a set of frequently occurring letter patterns. And if, for instance, the meaning of the word *flabbergasted* has to be analyzed it could be useful to transform the letters into sounds, pronounce them, and to look them up in the set of sound patterns. Words are analyzed fastest if both ways are always employed, and employed simultaneously. At the moment the slowest result is produced, a match between the two results – which should be equal – can be performed.

Another variant of the *two way error detection* is in principle possible based on the encoding activities that play a role alongside the decoding activities. When a word is read, information such as the meaning is derived by certain processes on the basis of the letter input. In order to produce speech to express the processed information, the meaning of the word has to be produced on the basis of the message that has to be expressed.

Whichever *double output test* is employed, it seems to be necessary to keep intermediate results in a memory because results that are compared will not be produced at the same moment. There is some evidence (Levelt & Kelter, 1982) that intermediate results of processes in the perception and production of language, such as the syntactic structure, are kept in a short-term memory for re-use. These memories are also necessary to enable processes to work in a parallel fashion (Kempen and Huybers, 1983). It seems likely that a lot of buffers are available to preserve all kinds of information which may be the input to other processes, and thus the intermediate memories are necessary anyway.

If in- and outputs of processes are kept in a short-term memory it should be made clear at what point they have to match. A possible way of doing this would be to assign a number or label to each output produced. Every process involved in the production and perception of language may be assumed to keep its outputs together with a rank order number or label in a short-term memory. If the rank order numbers or label of two outputs are the same, the outputs should be the same, otherwise an error is signalled to the *process monitor*. On these occasions the *process monitor* will start a number of actions. In the first place, the complete system should be stopped to make a correction possible. In the second place, the trouble has to be solved. In the third place, the error should be corrected by restarting at an appropriate point in the sentence that has been uttered so far.

What follows now is a short summary to evaluate the ideas presented so far about error detection when reading aloud. Every process involved in the language system performs its own basic control activities. Whenever a process should produce information, a check is made to see whether there is any result at all (*no result error detection* mechanism), whether the output is equal to a product from the same process on the basis of the same input in an earlier stage (*double way error detection* mechanism) or, finally, whether the output is equal to a product from another process that should lead to the same result (*two way error detection* mechanism). To make a comparison between intermediate results possible, these results have to be stored together with a rank number.

How can these local error detection mechanisms be evaluated with respect to the criteria formulated in section 2.2? The speed of language processing is affected very little since the control mechanisms can work in a parallel fashion to the language processing parts. The error detection activities are performed with a number of simple extra mental devices – mechanisms that decide whether there is a result at all and mechanisms that compare two strings of information of an identical nature. The information available to detect errors is used as much as possible; it is also used as fast as possible.

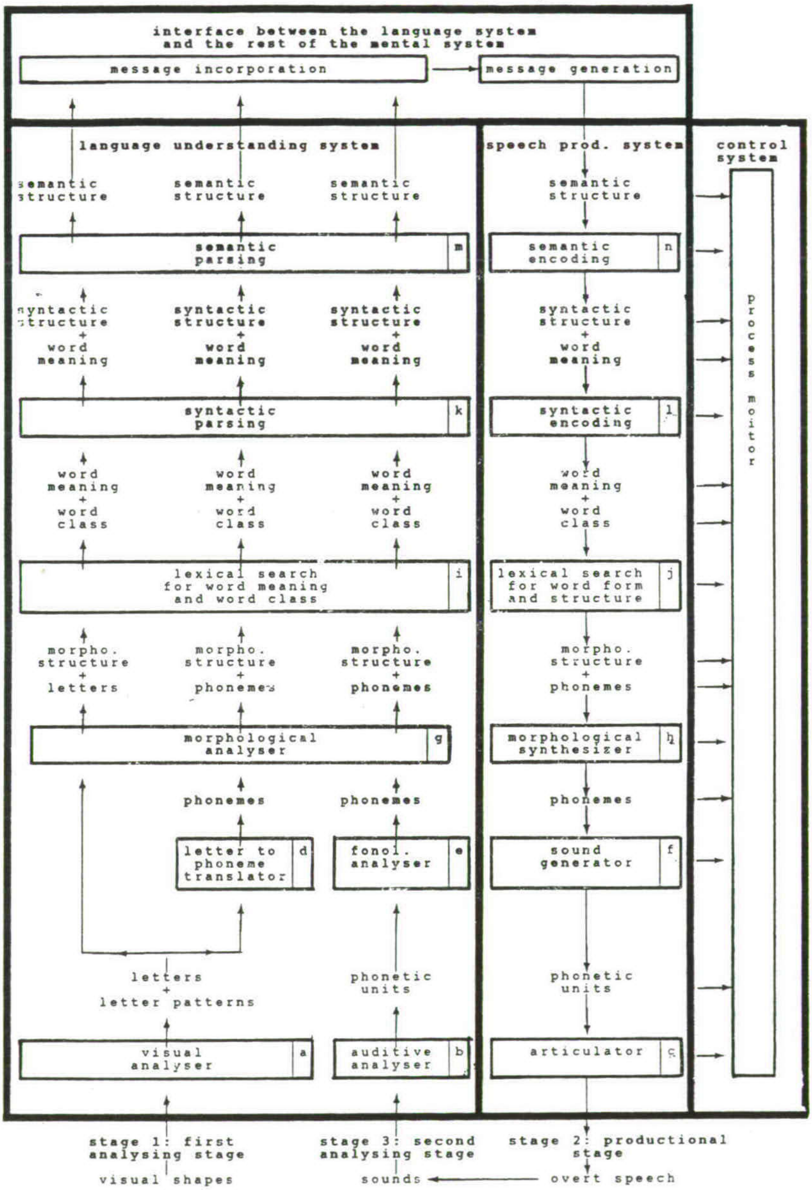

Figure 2.1 A diagram of the mental language system

2.4 A model of error detection in reading

A clear picture of the present monitoring theory is only possible within a detailed outline of the language system. In Figure 2.1 such an outline is presented. The starting assumption about the language system is that the processing of speech sounds and letter input is performed by a number of processes or modules that handle the various linguistic types of information. A process may consist of several subprocesses which in their turn may again consist of subprocesses and so on. Every individual process maps a given kind of information onto another one. Every process does its job independently of the other processes since it does not communicate directly with the other processes. The communication between processes is established via specific parts of the working memory to which every process is connected. Every piece of information is retained in the memory for some time. This offers the processes the opportunity to operate in an autonomous and parallel fashion: every process can take its input and produce its output whenever it is ready to do so (cascade model).

The outline of the human language system as presented in Figure 2.1 contains as its main elements a number of processes (represented by labels within boxes), types of information handled by the various processes (represented by labels without a box) and ways of access (represented by arrows) to specify the input and output of the individual processes. Furthermore, the occurrence of the same information at several points in time is indicated by a horizontal replication of the same product labels. The monitoring activities will be discussed after a more detailed discussion of the various parts of the language system. The diagram is actually based on a speaker-model as presented in Levelt and Schriefers (in press). However, that model can hardly be recognized in the present diagram since many changes were carried out to accommodate the special requirements that have to do with reading and error detection.

In the model, presented in Figure 2.1, four main processes are distinguished (represented as bold letter labels within thick-lined boxes). It is assumed that there is, first, a **language understanding system** which maps input like speech sounds and letters onto a conceptual code. To map conceptual codes onto output like sounds and letters there is, second, a **speech production system**. Third, there is the **interface between the language system and the rest of the mental system**. The role of this interface is first, to evaluate the incoming conceptual code by relating it to long-term memory information and filtering out what should be passed on to attention, i.e. conscious processes. Second, it generates a nonverbal code that contains the intentions to be expressed and that is suited as input for the **speech production system**. To handle the detection of errors within the language system there is, fourthly, the **control system**. These four components will be discussed in detail below. Before this discussion a remark should be made about the representation of chronology in the diagram.

As has been argued in the previous section, information concerning a specific word is processed in a kind of loop when reading aloud: it is analyzed, produced and analyzed again (called the **first analyzing stage**, the **productional stage**, and the **second analyzing stage**). Furthermore, the information can be processed by following various routes. This will lead to an asynchronous emergence of the same information. Whenever a product is processed more than once, the time course is represented from left to right within the individual compartments. In reading, the analyzing stage comes before the productional stage, so the **language understanding system** is presented to the left of the **language production system**. However, this does not mean that every product presented in the **language understanding system** comes up at an earlier moment than the products of the **speech production system**. The four main processes will now be discussed in the order in which they play a role when a certain word is read aloud.

1. The language understanding system. The input to the reading process consists of visual shapes which have to be recognized as an ordered sequence of elements that belong to a restricted set. This analysis is accomplished by the *visual analyzer*. It produces patterns of which the smallest units may correspond to one letter whereas the greatest may be complete words. This output is left in a memory area that is used as the input to two processes : the *lexical search* process and the *letter to phoneme translator*. In this study it is assumed that the letter patterns are always input to both processes. Thus, the events which follow after the production of the patterns will be discussed for each "way" or route the information takes.

The information consisting of letter patterns may be sufficient to recognize a word in the *lexical search* process, i.e. both word class and meaning become available. This information will be stored in another area of the working memory. Of a lexical element like 'man' the feature <noun> could be stored as syntactic word class information and features like <human> as semantic information. The word class information is used to decide what syntactic structure is being realized in the *syntactic parsing* process. If the input consists of the word classes <det> + <noun> + <verb> (as in 'The man talks.'), a different structure will result from the one with <aux> + <det> + <noun> + <verb> as its input (as in 'Does the man talk?'). The syntactic structure is combined with the meaning information to construct a full meaning representation by means of the *semantic parsing* process. The output is the end product of the **language understanding system**. There are no purely verbal properties left in this product. Thus, it will be possible to relate this information to other nonverbal information in the long-term memory (e.g. textual knowledge, situational knowledge [so-called *scripts*], encyclopedic knowledge etc.) in another process.

The information consisting of letter patterns may also be used by a process that transforms them into a number of phonemes: the *letter to phoneme translator*. The phonemes can be transformed into clusters of phonemes by the *morphological analyzer*. These structured sequences of phonemes can serve again as the input to the *lexical search* process. However, it will be clear that this information is available in most cases at a moment in time which differs from the moment the letter patterns are used by the *lexical search* process. The processing of the *letter to phoneme translator* and the *morphological analyzer* will have taken some time. This means that the word classes and meanings that are produced by following this way of information processing will be available at a different moment from those accessed solely on the bases of the letter information. They too are in turn subject to the operations of the *syntactic parsing* process and the *semantic parsing* process. The fact that only two ways are proposed to come from letter input to lexical search does not mean that these are the only two ways. Two ways are sufficient to illustrate the error detection mechanisms.

The **language understanding system** also plays a role in analyzing words that are read aloud. The characteristics of the sounds produced will be analyzed by a process that is capable of segmenting the analogous speech signal and distinguishing a limited set of units. This process, the *auditive analyzer*, produces elements which can be called phonetic units. After the transformation of this type of information into phonemes, the processing of the given word will be identical to the way followed when that same word is processed on the basis of the letter input: the *lexical search* process will assign a word class and word meaning, the *syntactic parsing* process will assign a syntactic structure after the processing of a number of word classes and the *semantic parsing* will lead to a complete analysis of the words that are read aloud. It is clear that the various types of information resulting from the analyses of the spoken word will be available some time after the analysis of the written word has been completed.

2. Interface between the language system and the rest of the mental system. After the analyses have transformed the incoming verbal code into a conceptual code, the information derived can be related to the information concerning that part of the text that was already read and the information available in the long-term memory. This is accomplished by a process which is called the *message incorporation* process. Its result may be handed over to the non-automatic and conscious mental processes which are capable of producing a rational and emotional evaluation of the incoming information. In Figure 2.1 these conscious processes are not represented since they are probably completely nonverbal in nature and therefore beyond the scope of this study. In reading aloud, the result of the **language understanding system** may be passed over to the **speech production system** via the *message generation* process. In reading this process is relatively unimportant; whatever has to be expressed is in principle determined by the text.

3. The speech production system. The semantic structure that has to be expressed is first subject to a process which decides what part of the meaning is expressed by one of the possible syntactic structures and what part is expressed by meaning units at the word level. This difficult job is carried out by the *semantic encoding* process. The *syntactic encoding* process produces the appropriate word classes of the words within the syntactic structure. Thus, the order of the realization of the words will also be specified. At this point the functional level representation is built (Garrett, 1980). Subsequent processes will produce the positional level representations. To do so, there is enough information for a detailed look up to get the individual units that are going to be expressed: the word form may be accessed in the *lexical search* process on the basis of word class and word meaning. The information provided by this process consists of phonemes of word stems and of information about how stems are to be combined with each other or with affixes. This combination is carried out by the *morphological synthesizer* resulting in sequences of phonemes. These phonemes which may be considered abstract sound representations are converted into concrete detailed sound representations by means of the *sound generator*. The result of the latter process suffices to plan the articulation of the sounds in the *articulator*. The subsequent execution of the articulation plan will lead to the production of speech sounds which will be the input to the **language understanding system** as discussed above.

One remark must be made about the possibility that a reader may produce inner or overt speech on the basis of intermediate results of the analysis instead of on the basis of the output of the message generator. For example, it is possible that phonetic units and subsequently overt speech are produced by taking the output of the *letter to phoneme translator* as its input. These short cuts between the first analyzing stage and the productional stage are of course possible. However, the errors that are found in reading aloud testify that in most cases information from the full range of levels are involved. The errors of deep dyslexics in particular show problems at a fairly high semantic level. On the other hand a reader must use products from the first analyzing stage. Otherwise it would be rare for the produced output to match the input completely; on the basis of the same output of the message generator a number different surface forms can probably be produced which are more or less appropriate.

4. The control system. Every process involved in the analysis or production of speech may either produce something or fail to produce an output within a limited amount of time when fed with an input. In all the processes there is a small box which symbolizes the device that tests whether the process produces its results in time (labelled with the letters a, b, c, etc.). This device is the *no result error detection* mechanism. How this device works is not yet completely clear (e.g. is there for every process a fixed time limit in which the process should come up with an result?). Whenever failure occurs, a signal is given to the *process monitor* to make it clear that an error must have occurred. Since the detection of an error may lead to such radical actions as restarting an earlier process or even drawing the attention to the fact that an error occurred, it is most implausible that every individual process would have the right to perform such actions. It seems fairly reasonable to assume that there should be a coordinating system that gathers signals from within the language system and takes these decisions: the *process monitor*.

As shown in the diagram a number of products come up more than once. At several moments the word class of a certain word is produced, the same is true for word meaning, etc. These results, which should be equal, may be subject to devices which check whether this is so: the *double way error detection* mechanism, and the *two way error detection* mechanism. The *double way error detection* mechanism works on products that are output by the same process in subsequent stages (e.g. the morphological structure produced by the morphological analyzer in the first and second analyzing stage). The *two way error detection* mechanism works on products that are output by different processes (e.g. the phonetic units produced by the sound generator and the phonetic units produced by the auditive analyzer).

The mechanisms that compare products within the language system are not represented within the diagram, since it is unclear where they are to be located; only the comparisons which can be made are indicated. All products with the same name may be compared.

What evidence is there that all the processes represented in the diagram play a role in the perception and production of language when reading? It is not the goal of this chapter to provide all the evidence there is for the existence of each individual process that is presented in the diagram. It can be argued that the processes as distinguished in the current model must have some reality since they all handle units of information which can be distinguished and produced separately when reading. Since a reader is capable of producing the correct sound belonging to a certain letter there must be at least one process that is capable of translating letters into another type of mental information which in turn can be transformed into sound by another process. Since readers can assign meaning to individual words which can be distinguished in a sequence of letters, there must be a process which produces this meaning. It seems fair to argue that since a reader can produce units like letters, morphemes, words, transformations of the syntactic structure of a sentence and paraphrases of the meaning of a sentence, these types of information must become available as separate units when the input that is analyzed consists of letters. Thus, there must be individual processes in the production system which produce these units of various types of information.

Another argument for the existence of individual processes may be found in the analysis of reading errors. It is true for all the processes in the diagram that the information they are supposed to handle is in some cases analyzed or produced erroneously when reading a text. It is possible that a sentence could be realized with the correct words as far as meaning is concerned but with an erroneous structure (e.g. "The man walks" realized as "Walks the mans") or, conversely, that a sentence could be realized with erroneous words as far as meaning is concerned but with a correct syntactic structure (e.g. "The man walks" realized as "The man talks"). Such errors suggest that the meaning of words and the syntactic structure of sentences are different types of information ordered in different units which are handled by different processes. Information like word class and word meaning seems to be organized in units of the same size: words. This makes it possible that they are processed simultaneously in the same process as is actually assumed in the *lexical search for word meaning and word class.*

The question of which processes play a role in the human language system is not the main subject of the current model of monitoring. What should be clear from the 'boxes' in Figure 2.1 is that if language is processed in a number of modules there are good opportunities for control provided that checks are made to see whether these modules fail to produce a result and whether results that should be equal are indeed equal. One could present the model in such a way that it corresponds closely to the two stage model for speech production of Garrett (1980). This would lead to the same picture as far as error detection is concerned. So, the main objective of Figure 2.1 is to illuminate the different error detection mechanisms; the reading model is most definitely incomplete and amendable.

2.5 How should the model be tested?

There are two aspects of the model that will be tested: first whether the different information sources are used in producing self-corrections, second, whether both *no result error detection* and *double/two way* error detection take place.

The research presented in this study starts with an investigation of what information sources and error detection mechanisms are involved in the detection of reading errors. This is done by an analysis of a corpus of reading errors and self-corrections (introduced in chapter 3).

Examination of a number of processes which are likely to play a clear role in the production and analyzing stages of reading is carried out to ascertain whether inadmissible errors lead to corrections (by *no result error detection*), and furthermore, whether deviant output leads to corrections (by the *double way error detection* and the *two way error detection*). It is possible to decide whether a given process (e.g. word meaning identification) has generated the correct output, an incorrect but linguistically possible output, or an inadmissible output by comparing the error to the target version. Errors can be classified with respect to each particular linguistic process with one of three categories: correct, incorrect or inadmissible (see examples [2.1], [2.2], and [2.3] for word meaning).

(2.1) Correct word meaning
T Toen *legde* de kip weer een ei in het hok.
R Toen *legt* de kip weer een ei in het hok.
ET Then the chicken *laid* another egg in the hen-house.
ER Then the chicken *lays* another egg in the hen-house.

(2.2) Incorrect word meaning
T Toen *legde* de kip weer een ei in het hok.
R Toen *pelde* de kip weer een ei in het hok.
ET Then the chicken *laid* another egg in the hen-house.
ER Then the chicken *peeled* another egg in the hen-house.

(2.3) Nonsense word
T Hoorde hij daar geen geschuifel?
R Hoorde hij daar geen *gesluifel*?
ET Didn't he hear any shuffling?
ER Didn't he hear any *sluffling*?

If the information from a certain process plays a role in the detection of errors, it is to be expected that realizations which are correct with respect to that process (but incorrect with respect to other processes) have a certain chance of being detected by other processes; however, incorrect and inadmissible realizations will probably have a higher chance of detection: they have the same chance of being detected on the basis of the other processes plus an extra chance on the basis of the process in question. So, if the correction chance of errors such as (2.2) or (2.3) is higher than that of errors such as (2.1), it may be concluded that word meaning plays a role in the detection of errors. A higher correction chance of errors of the type (2.2) must be based on the *double way error detection* or the *two way error detection*. A higher correction chance of errors of the type (2.3) must be based on the *no result error detection*. If errors are detected on the basis of one of the variants of the *double output test*, no further investigations are presented to differentiate between these mechanisms.

Chapter 3 Linguistic information used to detect errors

In this chapter analyses of a collection of errors and self-corrections are presented and tested to discover whether certain types of linguistic information play a role in detection according to the model introduced in the previous chapter. It starts with a short discussion about how the errors and corrections were collected and classified. This is followed by a discussion of the difference between error detection and correction. Subsequently, the analyses are presented and discussed.

3.1 The collection of errors and self-corrections

A collection of reading errors and self-corrections was gathered by the reading of a text by a group of good readers and a group of poor readers.

Material. The text that the children were to read had to be difficult enough to elicit sufficient errors: at least 25 errors (according to Goodman, 1973). On the other hand it had not to be too difficult since it is of course impossible to study the reading process if every word is realized incorrectly. To this end, a rather arbitrary criterion was used in the present study: not more than 25% of the words should be read wrongly. The selected text – "Staking op dierendag", of J. Kalmijn-Spierenburg in Lens and Van Keenen: *De boekenmolen 5*, Wolters-Noordhoff, Groningen 1974 – consisted of 800 words. On the basis of a pilot experiment it was expected that both the good and poor readers would make a number of errors that would fall between the lower limit of 25 errors and the upper limit of 200 errors (25%).

Subjects. The subjects were 25 children with severe reading problems and 21 children that had learned to read without any problem. The age of the good readers was on the average 10 years and 4 months (standard deviation of 5.2 months), the age of the poor readers was 10 years and 2 months (standard deviation of 9.4 months). The poor readers were selected from a LOM school, in Druten, and from a Paedological Institute, in Nijmegen. Both types of schools are attended by children with learning problems. The good readers were selected from two so-called 'Basis' schools, one in Druten and one in Nijmegen.

The selection of the children was done by their teachers using information that was already present in the records of the children. They were asked to select children who were at least average in intelligence, and who did not have severe social, emotional or physical problems. For the selection of poor readers their reading scores had to be on an appropriate low level (see chapter 1).

During the experiment, a test measuring the technical reading skills was administered: the *Differentiële zinnenleestest* (Differentiating sentence reading test; Dommerholt 1970). This test consists of reading sentences of increasing levels of difficulty for three minutes. The main parameter is the number of words that are read correctly. As expected, the good readers performed better on this test (a mean score of 58.1; 60 points is the maximum score) than the poor readers (a mean score of 32.6; $t(40) = -14.20$, $p < .001$, one-tailed).

Procedure. In the instructions the children were told that they had to read a text and that their reading would be recorded. It was emphasized that they should not read fast, but accurately. They were also encouraged to correct their errors.

The children read the text individually. Their reading time was restricted to a maximum of half an hour. This means that not all children read the complete text. The reading was recorded on tape. Then the reading test, mentioned above, was administered.

Results. To keep the statistical analyses simple, the number of poor readers was made equal to the number of good readers by disregarding the data of 4 randomly chosen poor readers.

Two judges independently noted down any deviation from the intended version to get a reliable (non-phonetic) transcription of what was read. These two transcriptions were compared and differences were discussed. The criterion to decide what should be counted as one error was based on the word as a linguistic unit. All the words or parts of a word produced in one attempt to read a particular word were counted as belonging to the same error. If the same word was read incorrectly on several occasions it was counted as a separate error (in the Goodman classification [Allen & Watson, 1976] this would be counted as one error). If errors were interrelated (e.g. subject and finite verb both in plural while the target sentences had singular forms) these errors were counted separately.

The starting point for the observation of reading errors is a deviation between a word on the paper and the word as it is realized. Errors of stress and intonation (e.g. Cutler, 1980) were disregarded. Every error was classified as either a substitution, an omission, an addition or transposition. Examples of these four types are given in (3.1) through (3.4).

(3.1) Substitution

T	(...), dat zijn *trouw* gewaardeerd wordt.
R	(...), dat zijn *vrouw* gewaardeerd wordt.
ET	(...), that his *faithfulness* is appreciated.
ER	(...), that his *wife* is appreciated.

(3.2) Omission

T	*En* de hond kreeg geen kluifje, (...)
R	- de hond kreeg geen kluifje, (...)
ET	*And* the dog did not get a bone, (...)
ER	- the dog did not get a bone, (...)

(3.3) Addition

T	'Dat duurt nog een jaar!' zei de boerin.
R	'Dat duurt nog een *heel* jaar!' zei de boerin.
ET	'That is still one year ahead!' the farmer's wife said.
ER	'That is still one *whole* year ahead!' the farmer's wife said.

(3.4) Transposition

T (...), waar de boerin het *niet kon* vinden.
R (...), waar de boerin het *kon niet* vinden.
ET (...), where the farmer's wife *could not* find it.
ER (...), where the farmer's wife *not could* find it.

Furthermore, a decision was made as to whether the addition was a real addition or merely a repetition or an instance of stuttering (correct but unfinished realization of a word, followed by its correct realization). In example (3.5) the word 'Dat' is repeated and the word 'vergeleken' is at first only partly realized. Such repetitions were disregarded in all the analyses since it is unclear what the trouble is.

(3.5) Repetition

T *Dat* is nog niets *vergeleken* bij wat ik doe, (...)
R *Dat Dat* is nog niets *vergelee vergeleken* bij wat ik doe, (...)
ET That is nothing in comparison with what I do, (...)
ER *That That* is nothing in *compa comparison* with what I do, (...)

The good readers produced fewer errors than the poor readers (see Table 3.1). Since 7 poor readers did not read the complete text, an adequate parameter of the reading behaviour in terms of errors was obtained by dividing the number of errors by the number of words read. As expected, the good readers made significantly less errors than the poor readers ($t(40) = 7.89$, $p < .001$, one-tailed).

	good readers	poor readers	total
Number of errors	881	2480	3361
Number of self-corrections	241	325	566
% Errors – words read	5.2	18.7	
% self-corrections – errors	27.4	13.1	

Table 3.1 The collection of errors and self-corrections of good and poor readers. (corpus of errors and corrections)

The self-correction behaviour was expressed as a proportion of the number of self-corrections divided by the number of errors (although this practice is open to question, Thompson [1984]). On the basis of the relation between reading proficiency and self-correction behaviour found by a number of investigators (see section 1.4,) it was expected that the good readers would correct a greater proportion of their errors than poor readers, and they did indeed correct a greater proportion of their errors (27.4%) than the poor readers (13.1%). This difference is statistically significant ($t(40) = -5.14$, $p < .001$, one-tailed).

3.2 Detection versus correction of errors

In the previous section it was shown that good readers correct a greater number of their errors than poor readers do. This difference may be caused by a deficiency in the detection of errors by poor readers or by the problems that poor readers have in constructing a correct version after having detected an error. To trace the cause of the small self-correction number of poor readers it may be useful to have some insight into the number of error detections compared to the number of successful corrections for good and poor readers.

Errors were classified as being detected whenever a second attempt at the same target word was observed (see example [3.6]).

(3.6) Detected error

T	'En ik dan? En ik dan?' *kakelde*	de kip.
R	'En ik dan? En ik dan?' *kuikelen kuikelt kukelde*	de kip.
ET	'And what about me?' And what about me?' *cackled* the chicken.	
ER	'And what about me?' And what about me?' *cickle cickles cockled* the chicken.	

The main reason why the reader comes up with 'kuikelt' after having realized 'kuikelen' must be that he is not satisfied with the first realization. Therefore the error in (3.6) is classified as being detected in spite of the lack of a self-correction.

Of the 572 substitution-errors made by the good readers, 178 were classified as being detected. Of the 2128 substitution-errors made by the poor readers, 534 were classified as being detected. This is 31.1 and 25.1 per cent for the good and poor readers respectively (the percentages of self-corrections were 27.4 and 13.1). The difference between the good and poor readers in proportion of errors that are detected is much smaller than the difference in the proportions of self-corrections. However, there is still a significant difference between the proportions of error detections by the good and poor readers ($t(40) = -1.73$, $p < .05$, one-tailed).

The good readers corrected 154 of the 178 errors they detected. The poor readers corrected 232 of the 534 errors they detected. At first sight it seems that poor readers have greater problems in correcting the errors they detect than good readers. To correct a reading error means first of all to read the word(s) again and try to analyze the input better. It seems reasonable to assume that the words whose reading resulted in an error are more difficult than the words which were read correctly at once. If those difficult words are read a second time in order to correct the detected error, there is again a chance that this reading will result in an error. Of the 16,800 words which the good readers read, 881 were read incorrectly. This means that any word in the text has a chance of being read incorrectly of roughly 1 in 20 (5%). If those readers made an error and started a second time in order to correct this error that correction went wrong 24 times (13%). Thus the chance of producing a second error on a word that already went wrong once is considerable for good readers. For poor readers the chance of initially reading a word wrongly was nearly 1 in 5 (2480 errors on 13,259 words read, 19%). Their chance of producing an error the second time after its detection was 57% (302 cases). For both groups of readers the number of errors nearly triples when a second attempt at a word is performed. The poor readers' performance in their second attempts is no surprise, given their high number of errors when reading a word initially.

In the analyses in this chapter, data are presented which are based on the detection classification as well as the self-correction classification. The former is considered to be the central variable in this study. The latter is presented to allow for comparisons with other studies.

linguistic information	category
letters	high similarity between error and target <D>
	low similarity between error and target
word class	indeterminate <N>
	different from the target <D>
	identical to the target
word meaning	indeterminate <N>
	different from the target <D>
	identical to the target
morphology stems	inadmissible structure <N>
	different from the target <D>
	identical to the target
morphology affixes	inadmissible structure <N>
	different from the target <D>
	identical to the target
syntactic context	correct
	incorrect <N>
	immediately incorrect<N>
semantic context	correct
	incorrect <N>
	immediately incorrect <N>

Table 3.2 The investigated categories of the various types of linguistic information. Between angle brackets is the error detection mechanism given that might detect the error: *D*ouble/two way or *N*o result. (corpus of errors and corrections)

3.3 Linguistic classification of the errors

As stated in chapter 2 the errors are classified for several types of linguistic information. If error and target are identical with respect to a certain type of information (e.g. are same with respect to word class), it is assumed that this type of information cannot be used to detect the error. The detection chance of these errors is the base line for studying the effect of both types of information. If the information is different (e.g. a noun is read as a verb) detection can be done by the *double way error detection* or the *two way error detection* mechanisms. If the error contains no admissible information with respect to the information in question (an non-existent word for example), the error can be detected by the *no result error detection* mechanism. Higher detection and correction scores for non-base line errors can be interpreted as evidence that the particular information and error detection mechanisms are involved in the detection of errors. The types of linguistic information investigated and the categories distinguished are given in Table 3.2. Examples of errors with respect to the linguistic types of information are given in the various analyses.

The errors were classified in separate rounds for the various types of linguistic information (for morphology there were two rounds). Each round was carried out by two judges who worked through the material twice. After each round the two judges as well as two new judges went over a randomly chosen subset of material. This resulted in estimates of the intra- and interjudge reliability of the classifications. The reliability of the various classifications – thus based on a test in which 4 judges in total were involved – are presented in Table 3.3.

	good readers		poor readers	
	inter	intra	inter	intra
word class	95	96	91	93
word meaning	82	84	75	82
morphology stems	97	97	95	93
morphology affixes	84	89	84	86
syntactic context	85	92	81	87
semantic context	83	92	83	89

Table 3.3 The inter- and intra-judge reliability of the error classifications. Percentages of similar judgements. (corpus of errors and corrections)

The number of times that the classification of an error turned out to be consistent when judged a second time by the same or by a different person, appears to be satisfactory.

More details and examples of the classification are given in the individual analyses of the types of linguistic information.

3.4 Analysis I: Letters

Data. A comparison of the letters and sounds was made for every substitution error. To this end, a measure was calculated for the correspondence between the error and the target word in terms of letters. The error was written down according to normal spelling rules and the correspondence was expressed in the graphic similarity index developed by Weber (1970a). This graphic similarity index takes into account the number of letters shared, the order of these letters, the difference in length between the error and the target word and the importance of the first and last letter of a response. Example (3.7) shows an error which is rather similar to the target word in terms of letters and sounds (index: 804). It is impossible to give an absolute maximum of this index since depends on the length of the two words involved. However, the maximum for one particular word can be calculated. If the word 'luisteren' had been realized correctly, the similarity index would have been 1111. Example (3.8) shows an error whose similarity with the target word is low (index: 365). The minimal index – in case of an omission of the complete word – is 0. The index would have been 1054 if the word 'zenuwachtig' had been realized correctly.

(3.7) High similarity (index 804)

T Als iedereen heerlijk slaapt, dan lig ik met gespitste oren te *luisteren* of er geen onraad is.

R Als iedereen heerlijk slaapt, dan lig ik met gespitste oren te *fluisteren* of er geen onraad is.

ET When everybody sleeps well, then I *listen* with strained ears whether there is any danger.

ER When everybody sleeps well, then I *glisten* with strained ears whether there is any danger.

(3.8) Low similarity (index 365)

T Dat deed hij altijd als hij *zenuwachtig* was.

R Dat deed hij altijd als hij *nieuwsgierig* was.

ET He always did that when he was *nervous*.

ER He always did that when he was *curious*.

Two mean indices of graphic similarity were obtained for each subject with respect to detections: one for those errors that were detected and one for those which were not. Two mean indices were also calculated on the basis of correction: one for the errors which were not corrected, and one for the errors which were corrected.

Expectations. Three predictions are made in advance: (i) Good readers will show a higher mean similarity index than poor readers. This is expected because good readers' errors are in general closer to the target (e.g. Clay, 1968). (ii) Errors that are detected or corrected will show a lower mean similarity index than errors that are not detected or corrected, because the more similar the errors are to the target, the less information there is for correction. (iii) This difference in mean similarity will be greater for good readers, since they make better use of the information available from all sources.

Results. The mean similarity index of all the good readers for all of their errors is 566. The poor readers show a mean index of 495. The mean indices of similarity for the four classes of errors are presented for both groups of readers in Table 3.4. An analysis of variance was carried out with the subjects as random factor. There was one within-subjects factor, error detection (levels: detected and not detected), and one between factor, the group of reader (levels: good and poor). The errors of good readers resemble the target words significantly more in terms of letters/sounds than the errors of the poor readers do ($F(1,40) = 5.72$, $p < .05$, one-tailed). The mean indices for detected errors are significantly lower than for undetected errors ($F(1,40) = 48.28$, $p < .001$, one-tailed). An analysis of variance that had as within factor self-correction (levels: corrected and not corrected), and as between factor, group of readers (levels: good and poor), showed that the corrected errors were significantly less similar to the targets that the un-corrected errors ($F(1,40) = 25.36$ $p < .001$, one-tailed). These findings suggest that the less similar an error is to the target word the greater the chance is that the error is detected and corrected. Thus, graphic similarity seems to play a role in error detection. No interaction between the type of readers and detection or self-correction was found.

corr. behaviour	readers	groups of errors	
error detection		undetected errors	detected errors
	good readers	544	445
	poor readers	605	508
self-corrections		uncorrected errors	corrected errors
	good readers	541	449
	poor readers	590	524

Table 3.4 The mean indices for graphic similarity in relation to the correction behaviour. (analysis I)

3.5 Analysis II: Word class

Data. For each word substitution error it was decided whether a word class could be assigned to the substitute word. If a word class was assigned to the substitute word, a comparison of word class was made between the substitute word and the target word. So, one of the three categories 'word class indeterminate', 'word class different', and 'word class identical' was indicated for each error (see [3.9], [3.10], and [3.11]).

(3.9) Word class indeterminate
- T De kinderen hebben niet voor niets zulke bolle *wangen*.
- R De kinderen hebben niet voor niets zulke bolle *ganen*.
- ET The children do not have such chubby *cheeks* for nothing.
- ER The children do not have such chubby *cheesk* for nothing.

(3.10) Different word class
- T Dat was een goed *idee*.
- R Dat was een goed *iedereen*.
- ET That was a good *idea*.
- ER That was a good *everybody*.

(3.11) Identical word class
- T Hij hoeft maar even met zijn tong te *klakken* en ik draaf al.
- R Hij hoeft maar even met zijn tong te *klanken* en ik draaf al.
- ET He only needs to *clack* his tongue and I'm on the go.
- ER He only needs to *clang* his tongue and I'm on the go.

Subsequently, mean proportions of error detection were calculated for each subject's errors that had the same word class as the target word, for errors which had a different word class and for errors to which no word class could be assigned. Similarly, the mean proportions of self-corrections were computed for the three types of errors.

Expectations. Errors of indeterminate word class or where the target has a different word class will be detected and corrected to a greater extent than errors where the target word is the same. This difference in detection and correction will be greater for good readers than for poor readers.

Results. In Table 3.5 results are presented for the good and the poor readers. If no word class can be assigned, the total group of readers shows a mean percentage of detection of 41.0. If the word class of the error is not the same as that of the target word, the proportion of errors detected is 30.1%. If the word class is realized correctly the detection incidence is 19.5%. The results for the self-correction behaviour are very similar.

corr. behaviour	readers	word class		
error detection		identical	different	undeterminable
	good readers	23.3	34.2	43.5
	poor readers	15.7	26.0	38.5
self-corrections				
	good readers	22.7	31.7	42.9
	poor readers	8.4	15.7	18.2

Table 3.5 The percentages of errors detected and corrected in relation to word class. (analysis II)

Two separate analyses of variance were carried out. One concerned the detection of errors and the other concerned the self-correction behaviour. They had as within-subjects factor, the type of word class error (levels: indeterminate, different, and identical), and as between factor, the reader group (levels: good and poor). The analysis of the incidence of error-detection showed a significant effect for the groups of readers ($F(1,40) = 2.99$ $p <$ .05, one-tailed). There was also a significant effect for the type of errors ($F(2,80) = 19.85$, $p < .001$). No interaction between the two groups of readers and the type of errors was found. The analysis of the proportions of self-corrections showed a significant effect for the groups of readers ($F(1,40) = 25.01$, $p < .001$, one-tailed). There was also a significant effect for the type of errors ($F(2,80) = 10.82$, $p < .001$). No interaction was found between the readers and the type of errors. So, the detection and self-correction behaviour of both groups of readers is clearly related to the word class of the error.

3.6 Analysis III: Word meaning

Data. A substitution error can be classified as either having no meaning (in the case of a nonsense word, example [3.12]), or as having a different meaning from the target word (example [3.13]) or as having a meaning which is closely related to the meaning of the target word (example [3.14]). The class of errors which preserves the meaning of the target word mainly consists of errors in which there is a small morphological deviation with respect to the target like in example (3.15). Due to the way errors are defined in this study (differing in at least one phoneme from the target word), there are no errors which are identical in meaning to the target.

(3.12) Word meaning indeterminate

T	Die *lelijke*	dief had wel een van (...)
R	Die *genijkende*	dief had wel een van (...)
ET	That *bad*	thief could have taken one of (...)

ER That *dabbered* thief could have taken one of (...)

(3.13) Different word meaning
T Die *lelijke* dief had wel een van (...)
R Die *lekkere* dief had wel een van (...)
ET That *bad* thief could have taken one of (...)
ER That *delicious* thief could have taken one of (...)

(3.14) Identical word meaning
T En de hond kreeg geen kluifje, maar gewoon *hondebrood.*
R En de hond kreeg geen kluifje, maar gewoon *hondebrokken.*
ET And the dog did not get a bone, but ordinary *dog-biscuit.*
ER And the dog did not get a bone, but ordinary *dog-cake.*

(3.15) Identical word meaning (small morphological error)
T (...) waar de boerin het niet *kon* vinden.
R (...) waar de boerin het niet *kan* vinden.
ET (...) where the farmer's wife *could* not find it.
ER (...) where the farmer's wife *can* not find it.

The proportion of the errors detected and the proportion of the errors corrected is calculated for the three types of errors.

Expectations. Errors where the meaning cannot be assigned or where the meaning differs from the target will be detected and corrected to a greater extent than errors that have a meaning similar to the target word. This difference in detection and correction will be greater for good readers than for poor readers.

Results. The results are presented in Table 3.6. The errors which are not meaningful are detected in 40.0% of the cases. Errors that do have a meaning but differ in meaning from the target word, are detected in 28.1% of the cases, and 13.3% of the errors closely related in meaning to the target word were detected. For the self-correction behaviour the data showed the same tendency.

corr. behaviour	readers	word meaning		
error detection		identical	different	undeterminable
	good readers	14.3	31.2	42.8
	poor readers	12.4	24.9	37.3
self-corrections				
	good readers	13.5	28.9	42.3
	poor readers	7.5	14.1	17.4

Table 3.6 The percentages of errors detected and corrected in relation to word meaning. (analysis III)

Separate analyses of variance were carried out for detection and for correction. They had as within-subjects factor, the type of word-meaning error (levels: indeterminate, different, and identical), and as between factor, the group of readers (levels: good and poor). The analysis of the error detection did not show a difference between good and poor readers ($F(1,40) = 1{,}64$, $p > .10$, one-tailed). There was, a significant effect of the type of errors ($F(2,80) = 28.88$, $p < .001$). No interaction was found between the two factors. The analysis of the self-correction behaviour showed an effect of the type of readers ($F(1,40) = 22.58$, $p < .001$, one-tailed), an effect of the type of errors ($F(2,80) = 16.69$, $p < .001$) and an interaction between these two factors ($F(2,80) = 3.97$, $p < .05$). Since this interaction is only found for the correction and not for the detection of errors, it is of minor interest for detection mechanisms. The conclusion from this analysis is that the meaning of an error plays a role in the detection and correction of errors.

3.7 Analysis IV: Morphological structure

Data. When dealing with a substitution error a comparison can be made between the morphological structure of both the error and the target word. Two types of morphemes are distinguished: the so-called free morphemes (e.g. 'table'), and bound morphemes, which occur only in combination with free morphemes (e.g. 's' in 'tables'). Bound morphemes bear a grammatical function. Only those errors where the target word and/or the error itself consisted of at least two morphemes were subjected to the analysis.

For the selected errors it was decided whether a bound morpheme had been deleted, added or substituted when compared to the target word. There were three categories concerning bound morphemes. First, errors keeping the same structure: in example (3.16) the error 'likte' (*licked*) as a realization of 'loeide' (*lowed*). Second, the structure differing between target and error: 'koe' (*cow*) differs morphologically from 'koeien' (*cows*). Finally, errors can have an internally incorrect structure, like 'beweegde' in example (3.17): 'bewegen' is an irregular verb, and in the error it is treated as a regular verb (in the English translation the regular verb *to move* is realized erroneously as an irregular verb).

(3.16) Identical and different structures of bound morphemes
T 'Het is een schande!' *loeide* de *koe*.
R 'Het is een schande!' *likte* de *koeien*.
ET 'It is a shame!' the *cow lowed*.
ER 'It is a shame!' the *cows licked*.

(3.17) Inadmissible structure of bound morphemes

T	Zag hij daar niet een donkere schaduw *bewegen*	bij het hek?
R	Zag hij daar niet een donkere schaduw *beweegde*	bij het hek?
ET	Didn't he see some dark shadow *moving*	near the fence?
ER	Didn't he see some dark shadow *moven*	near the fence?

Similarly, errors were classified relating to free morphemes covering the following categories: structures identical structure to the target, errors that consist of a different though regular Dutch combination of free morphemes, and morphologically inadmissible errors ([3.18] through [3.20]).

(3.18) Identical structure of free morphemes
T Het paard stampte aldoor met zijn *achterpoot*.
R Het paard stampte aldoor met zijn *achterpoten*.
ET The horse kept on kicking with its *hind-leg*.

ER The horse kept on kicking with its *hind-legs.*

(3.19) Different structure of free morphemes

T Het paard stampte aldoor met zijn *achterpoot.*

R Het paard stampte aldoor met zijn *poot.*

ET The horse kept on kicking with its *hind-leg.*

ER The horse kept on kicking with its *leg.*

(3.20) Inadmissible structure of free morphemes

T De kip had haar ei stilletjes achter de *hooiberg* gelegd, (...)

R De kip had haar ei stilletjes achter de *booierg* gelegd, (...)

ET The chicken had secretly laid her egg behind the *hay-stack*, (...)

ER The chicken had secretly laid her egg behind the *stay-ack* , (...)

Separate analyses were carried out for the proportions of errors detected or corrected with respect to the bound and to the free morphemes.

Expectations. Errors where the morphological structure is inadmissible or where it differs from the target, will be detected and corrected to a greater extent than errors that have a structure similar to that of the target word. This difference in detection and correction will be greater for good readers than for poor readers.

Results. The results are summarized in Table 3.7. If the morphological structure was identical to the target with respect to the bound morphemes, the good and poor readers detected on average 29.5% of their errors (for free morphemes this was 29.0%). If the structure happened to be different, the overall detection percentage was 32.4 (for free morphemes 22.9). If the structure was inadmissible, this led to detection in 33.4% of the cases (33.2% for free morphemes). The figures for the self-corrections show the same tendency.

corr. behaviour	readers	bound morphemes		
error detection		identical	different	inadmissible
	good readers	33.1	31.9	32.5
	poor readers	25.9	32.9	34.3
self-corrections				
	good readers	31.5	31.1	31.6
	poor readers	15.6	12.0	6.2
		free morphemes		
error detection		identical	different	inadmissible
	good readers	30.8	26.8	32.1
	poor readers	27.2	19.0	34.2
self-corrections				
	good readers	29.1	26.4	31.2
	poor readers	16.5	10.9	7.2

Table 3.7 The percentages of errors detected and corrected in relation to morphological structure. (analysis IV)

The detection data of the various types of errors concerning the realization of *bound morphemes* were evaluated by means of an analysis of variance. This had as within-subjects factor, the type of bound-morpheme error (levels: inadmissible, different, and identical), and as between factor, the group of readers (levels: good and poor). There was no main effect for the readers or the type of errors. The analysis of variance of the detection of several types of errors with respect to the structure of the *free morphemes* (within-subjects factor: free morpheme error) showed the same absence of effects and interactions.

The self-correction data in connection with the structure of *bound morphemes* showed a effect for the group of readers ($F(1,40) = 30.68$, $p < .001$, one-tailed). Again, there was neither an effect for the type of errors nor an interaction. An analysis of the *free morphemes* showed only a significant effect for the difference between the good and poor readers ($F(1,40) = 20.62$ $p < .001$, one-tailed) but no effect for the differences based on the type of errors.

The conclusion is that the structure of the bound and free morphemes does not play any role in the detection and correction of errors. This holds for both the good and the poor readers.

3.8 Analysis V: Syntactic context

Data. When a word is added, deleted or substituted within a clause or sentence, this may affect the syntactic structure of that clause or sentence. The present analysis is based on a classification of the errors in terms of their effects on the syntactic structure. A word error may result in a syntactically possible structure (example [3.21]) or in an incorrect structure. If the error results in an ungrammatical structure, two types of errors can be distinguished. First, there are errors which lead to an ungrammatical structure which is only recognizable as such after the realization of one or more words following the error. Second, there are errors which immediately cause the utterance to be ungrammatical. Example (3.22) leads to an incorrect structure. However, after the realization of 'hebben' it is still possible to finish in such a way that a possible syntactic structure results (in Dutch the word order is reversed after an adverbial phrase, so the error would be comparable to a situation in which *I* had been substituted for *he* instead of *has* as a realization of *have*). Therefore this type of error is considered to cause syntactic inconsistency which is not immediately detectable. The error in (3.23) leads to an immediately inadmissible syntactic structure: there is no way of finishing the structure properly. This division into two types of syntactic inconsistency is motivated by the idea that the errors which result in a delayed ungrammatical structure may be more difficult to detect than the errors which were immediately detectable on the basis of the grammatical context.

(3.21) Correct syntactic structure

T	Het *hoefde*	niet lang te duren.
R	Het *hoeft*	niet lang te duren.
ET	It *didn't*	have to last long.
ER	It *doesn't*	have to last long.

(3.22) Incorrect syntactic structure

T	Een heel jaar *heb*	ik mijn best gedaan voor de baas.
R	Een heel jaar *hebben*	ik mijn best gedaan voor de baas.
ET	During the whole year I *have*	done my best for the boss.
ER	During the whole year I *has*	done my best for the boss.

(3.23) Immediately incorrect syntactic structure

T	Ik *ben* tenslotte toch maar een klein dier.
R	Ik *het* tenslotte toch maar een klein dier.
ET	After all, I *am* just a small animal.
ER	After all, I *it* just a small animal.

For each subject, the proportion of error detections as well as self-corrections was obtained for errors which led to a grammatically correct structure, errors which led to an ungrammatical structure after the occurrence of the error and errors which immediately resulted in an ungrammatical structure.

Expectations. Errors that lead to an inadmissible syntactic structure will be detected and corrected to a greater extent than errors that lead to a correct structure. This difference in detection and correction will be greater for good readers than for poor readers. Errors which are immediately detectable will be detected more often than errors that are detectable after a delay.

Results. The results for the two groups are presented in Table 3.8. Errors which resulted in a structure that happened to be grammatically admissible, were detected in 21.2% of the cases. The errors classified as causing an incorrect grammatical structure detectable only after reading one or more words beyond the occurrence of the error were perceived in 50.8% of the cases, and 47.0% of the errors which immediately caused an impossible structure were detected. The role of syntactic context was almost the same for error detection and self-correction: if the context provided information for detection both detection and correction increased.

corr. behaviour	readers	syntactic structure		
error detection		correct	incorrect	immediately incorrect
	good readers	24.6	69.9	54.4
	poor readers	17.8	31.7	39.5
self-corrections				
	good readers	23.6	66.0	52.8
	poor readers	10.1	20.1	19.5

Table 3.8 The percentages of errors detected and corrected in relation to syntactic structure. (analysis V)

Two analyses of variance were carried out: one for the detection data and one for the self-correction data. They had as within-subjects factor, the type of error (levels: syntactically correct, syntactically incorrect, and immediately syntactically incorrect), and as between factor, the group of reader (levels: good and poor). The analysis of the good and poor readers' detection data showed a significant effect on the difference between the two groups of readers ($F(1,40) = 17.50$, $p < .001$, one-tailed). A significant effect was also found for the the type of errors ($F(2,80) = 42.84$, $p < .001$). Finally, the analysis also showed an interaction between the group of readers and the type of errors ($F(2,80) = 10.87$, $p < .001$). A comparison between the delayed detectable errors and the immediate detectable errors did not show any difference. The analysis of variance of the self-correction proportions yielded the same outcome: a significant effect of the difference between the two groups of readers ($F(1,40) = 50.21$, $p < .001$, one-tailed), a significant effect of the difference between the three types of errors ($F(2,80) = 32.49$, $p < .001$) and finally, there was an interaction between the group of readers and the type of errors ($F(1,40) = 11.82$, $p < .001$). Again, the immediately incorrect structures did not lead to a significantly different correction proportion compared to the delayed incorrect structures.

The conclusions are that syntactic context information is used to detect and correct errors, and that poor readers are not as good as good readers in this respect. Immediately and delayed detectable errors are detected to the same extent; the syntactic structure is probably incorrect to the same degree in both cases.

3.9 Analysis VI: Semantic context

Data. In the same way as the classification of errors on the basis of the syntactic context, every error was described as fitting the semantic context (example [3.24]), as causing a delayed incoherence with respect to semantic context (3.25) or as causing immediate incoherence (3.26).

(3.24) Correct semantic structure
- T De kinderen hebben niet voor niets *zulke* bolle wangen.
- R De kinderen hebben niet voor niets *leuke* bolle wangen.
- ET The children do not have *such* chubby cheeks for nothing.
- ER The children do not have *nice* chubby cheeks for nothing.

(3.25) Incorrect semantic structure
- T En de hond *bewoog* telkens zijn oren.
- R En de hond *begon* telkens zijn oren.
- ET And the dog *wiggled* his ears again and again.
- ER And the dog *started* his ears again and again.

(3.26) Immediately incorrect semantic structure
- T Het paard kreeg geen extra hapje *haver.*
- R Het paard kreeg geen extra hapje *haven.*
- ET The horse did not get an extra morsel of *oat.*
- ER The horse did not get an extra morsel of *harbour.*

The judgments on semantic coherence were restricted to the level of the sentence. The meaning of the sentences which preceded an error were not taken into consideration. The poor readers made so many errors that it was too difficult to decide what their semantic text representation could have been.

Expectations. Errors that lead to an incoherent semantic structure will be detected and corrected to a greater extent than errors that lead to a correct structure. This difference in detection and correction will be greater for good readers than for poor readers. Errors which are detectable after a delay will be detected to the same extent as errors which are immediately detectable.

Results. A view of the main data is presented in Table 3.9. Errors which did not lead to semantic incoherence were detected in 17.2% of the cases. Errors which did lead to an incoherence in meaning were detected in 46.7% of the cases where semantic distortion was detectable after a short delay. Errors which did not fit the preceding context and were thus immediately detectable on the basis of meaning were detected in 46.4% of the cases. The percentages for the self-correction behaviour were similar.

corr. behaviour	readers	semantic structure		
error detection		correct	incorrect	immediately incorrect
	good readers	18.1	63.6	53.5
	poor readers	16.3	29.9	39.2
self-corrections				
	good readers	17.1	60.5	51.8
	poor readers	9.2	18.8	19.6

Table 3.9 The percentages of errors detected and corrected in relation to the semantic structure. (analysis VI)

As in previous analysis, there were separate analyses for detection and correction data. They had as within-subjects factor, the type of error (levels: semantically correct, semantically incorrect, and immediately semantically incorrect), and as between factor, the group of readers (levels: good and poor). The analysis of the detection data showed a difference between good and poor readers ($F(1,40) = 13.17$, $p < .001$, one-tailed) and an effect of the type of errors ($F(2,80) = 40.45$, $p < .001$). Moreover, an interaction was found between these factors ($F(2,80) = 9.13$, $p < .001$). The analysis of the self-correction data likewise showed a significant effect of the group of readers ($F(1,40) = 43.68$, $p < .001$, one-tailed) and of the categories of errors ($F(2,80) = 30.3$, $p < .001$). The interaction between the two factors was also significant ($F(2,80) = 11.09$, $p < .001$). There was no difference between immediate and delayed detectability in both analyses.

The detection and correction of errors is clearly related to the way in which the errors fit the preceding and following context. The poor readers do not use this information to the same extent as good readers do.

3.10 Analysis VII: Combination of information

Analysis VII A. Each analysis discussed so far has focussed on the use of only one type of information to detect and correct errors. In this section the interaction between several sources of information for detecting an error is studied. Questions such as the following can be considered: in how many instances are errors detected which differ from the target word both in word class and in word meaning? However, instead of presenting all the possible combinations of differences between error and target and types of inadmissible outcome, the best detectable combination is searched for. A discriminant analysis is carried out to determine which combination of information types maximizes the chance of detection and self-correction.

Data. The error categories which were distinguished in the previous analyses constituted the basis for the present analysis. For every error the index of graphic similarity was given. Furthermore, for each error a three-category classification (error identical to the target, error different from the target and error inadmissible) was provided with respect to word class, word meaning, bound morphemes and free morphemes. Two three-category classifications with respect to context were given. The errors were classified with respect to their syntactic as well as semantic context (error leading to a coherent structure, error leading to an incoherent structure which is only recognizable after the occurrence of the error, and error leading to an incoherent structure which can immediately be recognized as such). The main variable within the discriminant analyses was of course the detection or self-correction classification for each error. Separate analyses were carried out for the good and the poor readers and for the detection and self-correction classification, but since these analyses showed nearly the same results only the results of the analysis of detection data are presented.

Results. The discriminant analysis for the good readers showed that the best information for detection is provided by a combination of the variables syntactic context, graphic similarity index and word meaning. For the poor readers, the best combination of variables to predict detection was semantic context, graphic similarity and word meaning. However, error detection is still very difficult to predict. When using this combined information, 63.1% of the good readers' errors are correctly assigned as being detected or not being detected. For the poor readers this percentage is 59.3. The conclusion is that such combinations of information do not explain the correction behaviour very well; differences between good and poor readers are of minor importance. The outcome when analyzing the correction behaviour is nearly the same as for the detection behaviour.

Analysis VII B. To get a more detailed picture of the accumulation of information used to detect an error, an analysis was carried out which focussed more specifically on that phenomenon. For every error the number of sources available for detection was ascertained, and then investigations carried out to discover whether an increase in the number of sources correlated with an increase in detection.

Data. For every error the number of available sources for error detection was calculated. If there was a difference between the error and target in word class, word meaning, bound morphemes or free morphemes, the score was increased by one. The index of graphic similarity was divided into two categories: great similarity and little similarity. For the errors that were categorized as having little graphic similarity, the score was raised by one. In this way, the accumulation score that was assigned to every error ranged from 1 to 5 (the few errors which showed a score of 0 were excluded from the analysis). This score will be called the error-target difference score.

A similar accumulation score was computed based on the inadmissibility or incoherence of an error (word class, word meaning, morphology [twice], syntactic context and semantic context). This score ranged from 1 to 6, and will be called the inadmissibility score. Subsequently, for each subject the proportion of detected errors for the 5 categories defined by the error-target difference scores and for the 6 categories of the inadmissibility scores. Separate analyses were carried out for the good readers and the poor readers.

Results. The correlation between the error-target difference score and detection is $r(103) = .12$, $p > .10$ for the good readers and $r(103) = .21$, $p < .05$ for the poor readers. For the inadmissibility score the correlation for the good readers turned out to be: $r(124) = .34$, $p < .001$ and for poor readers $r(124) = .36$, $p < .001$. The correlation between self-corrections and error-target difference scores was not very strong for the good and the poor readers ($r(103) = .11$, $p < .01$; $r(103) = .13$, $p < .05$). For the inadmissibility scores the correlations were: $r(124) = .34$, $p < .001$ and $r(124) = .19$, $p < .05$ for the good readers and the poor readers respectively.

In general the correlation between the number of information sources and detection or correction is low. This means that accumulation of information for error detection does not lead to a clear increase in detection or correction incidence.

3.11 Discussion

The analyses yielded a number of interesting results. If an error differs from the target with respect to certain types of linguistic information (letters, word class, and word meaning), this difference is obviously used to detect and correct errors. These findings form firm evidence for local monitoring activities by the *two way error detection* or *double way error detection* mechanisms. If an error is inadmissible or incoherent with respect to certain types of linguistic information (word class, word meaning, syntactic and semantic context), this is also used for error detection and correction. This points in the direction of local monitoring activities based on the *no result error detection* mechanism. The results support the model of error detection as discussed in chapter 2.

There is one type of information which seems to be neglected in the detection and correction of errors. Morphological information does not play an important role in the detection of errors. Explanations for this finding can be sought in two directions. First, this type of information is not very important or the information is not available to the detection mechanisms. Young readers may neglect morphology to some extent; as long as the main free morpheme of the word is correct and the word class remains unchanged, relatively little harm is done to the syntactic and semantic structure of the sentence. Thus the correction of errors may have a very low priority as far as morphological information is concerned. A second explanation is that morphological information is not subject to detection mechanisms. The simplest explanation in this direction is that this type of information is not handled in a separate process. Although it can be distinguished as a separate linguistic type of information within sentences, the analyzing and generating activities concerning this information are then realized as a part of other processes. Neither explanation is very attractive. However, the empirical evidence so far available is not enough to formulate a clear explanation.

The results of the analyses with respect to combining the information for detecting the errors were contrary to expectations. For a number of sources of information it has been demonstrated that the chance of error detection was dependent on their outcome. The normal expectation would then be that if there are more sources which provide the information that an error occurred, the chances of detection will increase with every additional source that is available. At least it may be expected that the resulting chance of detection, if it is based on a number of sources of information, should be higher than all the chances based on the separate sources. The correlation between the accumulation of information and correction behaviour was not very high. One possible explanation for this finding is that the variation in detectability caused by a given information source is not distinct from the variation in detectability caused by the other sources. An error is often detectable on the basis of a number of sources of information. If the information sources are highly intertwined, this leads to a situation where analyses concerning different error detection sources actually capture the same errors and error detection phenomena. If the analyses of word class and lexical meaning are based on the same sets of errors being classified as different from the target word, the results will not only be the same for both analyses but also for the analysis based on the combination of information concerning word class and lexical meaning. This explanation will be tested in chapter 5.

The results offer an explanation for the difference in detection between the good and poor readers. The good readers seem to make better use of the syntactic as well as the semantic context. If an error leads to incoherence in context, the chances of error detection are increased for both groups. For the good readers, this increase is significantly higher than for the poor readers. The question arises whether this obvious problem of handling larger syntactic and semantic structures is caused by their reading problem or whether it partly causes their reading problem. Without going into details, it is possible to assume that very severe reading problems (e.g. the recognition of a word on the basis of letters) puts such a heavy load on the language system that the more sophisticated processes such as the incorporation of the results of the former recognition processes into larger structures are distorted. It could well be that the more sophisticated processes do not receive enough time and memory to function properly. On the other hand, it is possible that the processes involved in building or analyzing syntactic and semantic structures function inadequately for the poor readers. It is clear that if these processes do not function very well, important information is lost for poor readers, which will cause problems in reading.

Whichever explanation is correct, it may be concluded that under certain circumstances (the text that the poor readers have to read, the task of reading aloud, etc.) poor readers do not manage to make full use of contextual information.

Chapter 4 Parts of self-corrections

In the previous chapter the types of linguistic information used to detect errors were investigated. The main data for those analyses was the incidence of correction and detection for different types of errors. The analyses presented in this chapter are concerned with the structural aspects of the self-corrections. The goal is to find evidence which supports the findings of the previous analyses but which is based on a different kind of data.

A self-correction is a phenomenon which can be described as a structure consisting of three parts. As stated in chapter 1 it may consist of the original utterance, the editing phase and the repair. The original utterance contains an error and may show a delay of interruption (a number of words pronounced after the error before the correction is produced). The editing phase may contain a pause and editing terms. The repair contains the actual correction and may contain a so-called retrace: the speaker or reader starts his correction a number of words before the word that has to be corrected. The analyses presented in this chapter concern three aspects of the self-correction: the delay of interruptions, the kinds of editing terms and the span of retracing. These analyses may shed some light on the information that is used to realize a self-correction.

The analysis of the moment of interruption focusses on the same factors as the analysis of detection and correction incidences in chapter 3. The question is whether the information that played a role in the detection and correction behaviour also affects the moment of interruption.

In speech, editing terms turn out to be different for different types of trouble and mark how recent the error is (Levelt, 1983). Since errors were classified in the previous chapter according to a number of different sources for detection, investigations will be carried out to discover whether the readers give any clues about the source of the error or the recency of the detection by uttering particular editing terms.

The analysis of the span of retracing will focus on the use of syntactic context information and the difference between good and poor readers in this respect. The place in a sentence which a reader chooses to restart after he has detected an error could be based on his knowledge about the syntactic structure which is realized.

The chapter concludes with a discussion of the findings with respect to poor readers.

4.1 Delay: the Main Interruption Rule

The first part of a self-correction which is of interest is the delay of interruption. This is the "material span between error and new start" (Nooteboom, 1980). After an error occurs, zero, one or more linguistic units can be realized before the flow of speech is stopped in order to correct it. In the present analysis the delay is expressed in terms of numbers of words. The error in example (4.1) is corrected almost immediately after its occurrence (delay is 0). In example (4.2) the delay is 5 (in the English translation it involves only 2 words).

(4.1) Delay 0

T De koe bleef *geduldig* staan, toen ze gemolken werd.

R De koe bleef *gedrukkelijk ... geduldig* staan, toen ze gemolken werd.

ET The cow remained standing *patiently*, while it was being milked.

ER The cow remained standing *pretation ... patiently*, while it was being milked.

(4.2) Delay 5

T Toen *legde* de kip weer een ei in het hok.

R Toen *leegde de kip weer een ei ... legde* de kip weer een ei in het hok.

ET After that the chicken *laid* another egg in the hen-house.

ER After that the chicken *emptied another egg ... laid* another egg in the hen-house.

The frequencies of the various delays in the self-correction collection of the good and the poor readers are presented in Table 4.1.

readers	delay (lengths in words)					
	0	1	2	3	4	5	>=6
good readers	121	69	17	6	4	4	2
poor readers	234	53	15	6	2	2	0

Table 4.1 Distribution of self-corrections over the various delays. (analyses VIII - VIII)

The good readers showed a delay of 1 or more words in 45.7% of their self-corrections (N = 223). For the poor readers this percentage was 25.0 (N = 312). To obtain a description of the self-correction behaviour of individual subjects in terms of delay, the mean delay is computed (the total of all the delays of a subject divided by the number of his self-corrections). The good readers had a mean of delay of .81 and the poor readers .38. The difference between the good and poor readers in the distribution of delays (Table 4.1) was significant when tested with a chi-square test $\chi^2(6) = 17.49$, $p < .001$). To formulate an explanation for this difference between the two groups of readers, it will be necessary to consider in detail the cause of the delay in self-corrections.

Explanations for the variation in the moment of interruption can be sought in two directions. A delayed interruption could be based on the structure of the sentence which is to be realized. On detecting an error the language system could search for an appropriate point in the structure to stop. This procedure could be motivated by considerations concerning the listener. The speaker could strive for the presentation of a language structure which is – in spite of the occurrence of an error – as transparent as possible. This could be achieved by stopping at the end of a unit in the realized structure instead of in the middle of such a unit.

The alternative explanation is based on the detection of the error. The assumption then is that a reader sometimes reads a number of units after the occurrence of an error because the error has not yet been detected.

A number of researchers of speech error corrections (Nooteboom, 1980; Levelt, 1983) have studied what is called the Main Interruption Rule, which states: 'Stop the flow of speech immediately upon detecting the occasion of repair.' (Levelt, 1983; p. 56). Levelt identified in his collection of repairs linguistically interesting points like morpheme boundaries, words and various types of constituents. Then he investigated whether speakers show a preference to stop at those points. The main conclusion from speech errors is that speakers show no tendency to stop at structurally important boundaries with the exception of words (they are finished if they are correct).

Another way to decide whether the delayed interruptions are caused by a tendency to produce a good structure or because the error is not detected immediately can be provided by the study of the detectability of the error. If the delayed interruption is caused by a delayed detection of the error, the delay must be correlated to the detectability of the error. In chapter 3 it was demonstrated that an error whose word class was different from that of the target word had a greater chance of being detected than an – in other aspects comparable – error whose word class happened to be the same. If the delayed interruption can be interpreted as the time that is needed for detecting the error, this leads to the assumption that errors which are more easily detectable should show a smaller delay than the errors which are difficult to detect. If the word class is different from that of the target word, errors should be corrected with relatively smaller delays than in those cases where error and target are equal in word class. Separate analyses are carried out for each of the sources of linguistic information that were investigated in the previous chapter. The general hypothesis is that whenever linguistic information is available which, according to the results of the previous chapter, can be used to detect errors, such information will lead to smaller delays.

Every analysis is examined to ascertain whether the distribution of the delays is different for the various categories of errors. There are six delays: zero, one, two, three, four, or five and more words. Since it turned out that differences in distribution can be described very well in terms of the mean delay, this measure is presented instead of the distributions. The mean delay is computed on subsets of all the self-corrections made by a group of readers. When the subset of self-corrections is defined as the corrections of those errors whose word class is different from that of the target word, and when the group of readers is defined as that of the poor readers, the mean delay is the sum of the delays (of the defined subset of the self-corrections made by the poor readers), divided by the total number of self-corrections (of the defined subset made by the poor readers).

Analysis VIII: graphic similarity. The self-corrections of the good and the poor readers were divided into three groups based on the index of graphic similarity. For the good readers 38 corrected errors were classified as having a high graphic similarity, 43 as having a moderate graphic similarity and 87 as having little graphic similarity. For the poor readers these numbers were 82, 68 and 133 respectively. For every group of errors the frequencies of the 6 delays were counted, and separate analyses were carried out for the good and the poor readers.

Results. The mean delays corresponding to the various degrees of graphic similarity are shown in Table 4.2.

graphic similarity	readers	
	good readers	poor readers
high level of similarity	0.47	0.27
moderate level of similarity	0.41	0.27
low level of similarity	0.75	0.23

Table 4.2 The mean delay of self-corrections in relation to various levels of graphic similarity. (analysis VIII)

A chi square was calculated for both groups of readers in order to find out whether the distribution of the delays was different for the three types of errors (accordingly, the analysis was carried out on the distributions and not on the mean delay, which is more convenient to present). For both groups it turned out that there was no significant difference in the distribution of delays between errors with a high level and errors with a moderate level of graphic similarity $\chi^2(5) = 0.02$, $p > .10$ for good readers, and $\chi^2(5) = 1.29$, $p > .10$ for poor readers), nor between errors with a high graphic similarity and errors with little similarity $\chi^2(5) = 1.17$, $p > .10$ for good readers, and $\chi^2(5) = 0.09$, $p > .10$ for poor readers). The results do not support the general hypothesis.

Analysis IX: word class. The corrected errors were divided into three groups. The good readers corrected 57 errors whose word class was identical to that of the target word. In 44 of their self-corrections the word class differed from that of the target word. And in 67 of their self-corrections no word class could be assigned to the incorrect word-substitution. For the poor readers these figures were 69, 96 and 118. The frequencies of the various delays were calculated for each group of errors.

Results. The mean delays are summarized in Table 4.3.

word class	readers	
	good readers	poor readers
correct	1.10	0.40
incorrect	0.80	0.26
inadmissible	0.21	0.22

Table 4.3 The mean delay of self-corrections in relation to word class information. (analysis IX)

The delays did not differ significantly when the word class of the error and the target were the same or incorrect $\chi^2(5) = 5.65$, $p > .10$ for good readers, and $\chi^2(5) = 7.79$, $p > .01$ for poor readers). If no word class could be assigned to the error, the number of delays was significantly lower then when the word class of the error and target were the same $\chi^2(5) = 52.20$, $p < .001$ for good readers, and $\chi^2(5) = 16.95$, $p < .01$ for poor readers). These later findings are in accordance with the general hypothesis.

Analysis X: word meaning. Fifteen of the good readers' corrections could be classified as involving a substitution which resembled the meaning of the target word very closely. Fifty-four of their self-corrections involved an error with a different word meaning and in 78 cases no meaning could be assigned to the errors. For the poor readers these figures were 27, 142 and 98 respectively.

Results. In Table 4.4 the mean delays are presented for the different types of errors made by the good and the poor readers.

word meaning	readers	
	good readers	poor readers
correct	1.03	0.41
incorrect	0.96	0.30
inadmissible	0.21	0.22

Table 4.4 The mean delay of self-corrections in relation to word meaning. (analysis X)

The differences between the types of errors were statistically significant for the good readers (correct versus incorrect: $\chi^2(5) = 16.96$, $p < .01$, and correct versus inadmissible: $\chi^2(5) = 24.44$, $p < .001$). For the poor readers the results were similar $X2(5) = 13.01$, $p < .05$) for correct versus inadmissible. These findings were as expected. However, the poor readers did not show a significant difference between correct versus incorrect $\chi^2(5) = 10.32$, $p < .10$).

Analysis XI: morphological information. The self-corrections were classified with respect to bound and free morphemes in two separate analyses. In the analysis of the bound morphemes the corrected errors were divided into 3 groups. The first group consisted of errors which, from a structural point of view, were completely identical to the target word. The second group consisted of errors whose bound morpheme-structures differed from those of the target words, and the third group consisted of inadmissible structures with respect to the bound morphemes. The good readers produced 103 self-corrections on errors belonging to the first group and 24 and 18 belonging to the second and third group. The poor readers produced 163, 40 and 41 self-corrections on errors of these three types.

The analysis of the structure as regards free morphemes was also based on a tripartite division: identical in structure, different in structure and having an inadmissible structure. The good readers showed respectively 30, 87 and 64 corrected errors of these three types and the poor readers 22, 140 and 58.

Results. The results with regard to the bound morphemes and the structures of free morphemes are given in Table 4.5.

bound morphemes	readers	
	good readers	poor readers
correct	1.23	0.35
incorrect	0.67	0.28
unassignable	1.00	0.33
free morphemes	**readers**	
	good readers	poor readers
correct	0.35	0.37
incorrect	0.79	0.28
unassignable	0.23	0.28

Table 4.5 The mean delay of self-corrections in relation to morphological information. (analysis XI)

The figures presented in Table 4.5 do not suggest a clear relation between the type of error from the point of view of morphology and the mean delay. As could be expected from these data no difference in distribution could be found for the three types of affix errors. This was true for both the good readers (correct versus incorrect: $\chi^2(5) = 0.95$, $p > .10$; correct versus inassignable: $\chi^2(5) = 1.02$, $p > .10$) and the poor readers $X2(5) = 0.06$, $p > .10$; $\chi^2(5) = 0.32$, $p > .10$). The same holds for the structures of the free morphemes, where again, no significant differences in delay frequency could be found for the various types of error (good readers: $\chi^2(5) = 0.83$, $p > .10$; $\chi^2(5) = 1.11$, $p > .10$ and poor readers: $\chi^2(5) = 0.50$, $p > .10$; $\chi^2(5) = 2.10$, $p > .10$). That interruptions occur independently of the morphological structure of the error is in line with the findings of chapter 3: morphological information does not play a role in the detection of errors, and this fits in with the general hypothesis.

Analysis XII: the syntactic context information. The analyses of the self-corrections were classified on the basis of the possible syntactic incoherence caused by the error. Three types were distinguished: errors that were correct within the realized utterance as a whole, errors that were correct at the moment of uttering, but which caused a syntactically impossible structure at some point after the occurrence of the error and finally, errors that were immediately incorrect. For the good readers this classification of the self-corrections yielded 39 corrections of errors of the first type, 51 corrections involving errors of the second type and 71 corrected errors of the third type. For the poor readers these numbers were 56, 79 and 140 respectively.

Results. The results are presented in Table 4.6. The good readers

syntactic structure	readers	
	good readers	poor readers
correct	0.84	0.34
delayed incorrect	1.34	0.38
immediately incorrect	0.27	0.23

Table 4.6 The mean delay of self-corrections in relation to syntactic context information. (analysis XII)

and poor readers did not show a significantly different distribution of delays for errors which did not cause an inadmissible structure and those that caused an inadmissible structure at some point after the occurrence of the error (for the good readers: $\chi^2(5) = 4.70$, $p > .05$, and for the poor readers: $\chi^2(5) = 0.77$, $p > .10$). The difference between the errors which were syntactically correct and those which were immediately incorrect was significant for good readers $\chi^2(5) = 12.06$, $p < .05$). This difference was not significant for poor readers $\chi^2(5) = 3.73$, $p < .10$). These latter findings are not only in accordance with the general hypothesis, but support also the difference in use of syntactic context information between good and poor readers as found in the previous chapter.

Analysis XIII: the semantic context information. The self-corrections were divided into three groups as far as the semantic structure is concerned. The good readers made 28 self-corrections involving errors which did not lead to an impossible semantic structure. They corrected 62 errors which led to a highly implausible or even impossible structure at some point after the occurrence of the error and 71 errors which immediately led to an impossible structure. For the poor readers these data were 41, 87 and 147.

Results. The results are very similar to those found with respect to the syntactic context. They are presented in Table 4.7.

semantic structure	readers	
	good readers	poor readers
correct	0.76	0.27
delayed incorrect	1.28	0.39
immediately incorrect	0.27	0.23

Table 4.7 The mean delay of self-corrections in relation to semantic structure. (analysis XIII)

For the good readers, the difference between the errors which did not lead to an impossible structure and those which did at some point after the error turned out to be marginally significant $\chi^2(5) = 10.01$, $p < .10$). The difference between the errors that fitted the context and those that immediately led to an impossible structure was significant $\chi^2(5) = 21.25$, $p < .001$). For the poor readers, the difference in delay between the corrections of the errors which did not lead to an incorrect structure and the corrections of those errors which did lead to an incoherent structure at some point after the occurrence of the error was not significant $\chi^2(5) = 0.28$, $p > .10$) The same holds for the difference between the errors which did not lead to an impossible structure and those which immediately did $\chi^2(5) = 3.33$, $p > .10$).

Discussion and conclusions. The Main Interruption rule seems to be confirmed by the results: the moment of interruption is related to detectability. It was proved for several sources of information - which according to the findings of chapter 3 are used for error detection - that if they provided information for error detection this led to a significant decrease of the delay.

Although not significantly, good readers showed a clear increase in the delay if the error could only be detected on the basis of contextual information at some point after the occurrence of the error, when compared to errors where the context gave no clue that an error had occurred. If the information that an error has occurred can be found at some point after the error, this will lead to more corrections (see previous chapter) but with these corrections the delay is high. This finding testifies again to the relation between detectability and moment of interruption. The poor readers, who - according to the analysis of the previous chapter - do not use this delayed context information to the same degree as the good readers and therefore correct fewer errors of this type, do not show such a relation between the context information and the moment of interruption.

The results of the analyses of the moment of interruption can be seen as a fairly independent replication of the results of the previous chapter: word class, word meaning, syntactic structure and semantic structure play a role in the detection and correction of errors, but can also explain a great deal of the variation in delay. The morphological properties of the error do not influence the incidence of detection or correction and bear no relation to the delay.

An unexpected finding was that no connection could be established between the graphic similarity index and the delay. A number of explanations could be given for this. One explanation is that if an error is detected on the basis of a discrepancy with respect to graphemes-phonemes, this detection will always be very fast since there is no use in remembering phonemes that have already been realized. Information such as word class and word meaning can be re-used at a later moment to handle emerging context problems in case of ambiguity. There may be other explanations. The analysis presented here is in no way conclusive on the question of what explanation is valid.

Good readers differ from poor readers in a number of ways. The mean delay of good readers is higher than that of poor readers. Since it may be assumed that the delay shows the time needed to detect the error this could mean that good readers are relatively slow in detecting their errors. However, since the number of words read after the error is used as the measurement of the delay, differences in reading speed will influence the results. Good readers read much faster than poor readers (for the text used in the current analysis: good readers read about 2.1 words per second; the poor readers read about .5 words per second). If both groups need the same time to detect the errors, the good readers read more words during that time than poor readers. It is plausible to explain the difference in mean delay between the good and poor readers by the difference in reading speed.

For poor readers no evidence was found that the information concerning syntactic and semantic contexts affects the moment of interruption. The good readers, however, did show such a relation. This difference in the role of the context is in line with the findings of the previous chapter.

4.2 Editing terms

The second part that is of interest in the realization of a self-correction is the editing phase. This part between interruption and restart for correction may consist of a pause, possibly filled with so-called editing expressions (Hocket, 1967). In studies of self-corrections in speech it is assumed that during the editing phase the actual correction is planned. The editing terms are related to the type of error to be corrected. Levelt (1983) showed that an editing term like the Dutch 'Uh' marks that trouble is still recent.

In the collection of self-corrections of reading errors by the good and poor readers, editing terms were scarce. The good readers only once produced one editing term: 'nee' ('no'). The poor readers produced '(oh,) nee' (['oh,] no') in 39 of their self-corrections and in 4 cases 'hm'. These readers also produced some small utterances which were directed to the experiment leader: 'Wat is dit?' ('What is this?'), 'Wat staat daar?' ('What does it say?'), 'Is?' ('is?'), 'Moet ik dit allemaal lezen?' ('Do I have to read all this?'). That good readers do not produce editing terms suggests that whatever function these terms have in the correction of speech errors, this function plays no role in reading.

There are a number of differences between the production of language in speaking spontaneously and reading aloud. Maybe the fact that a reader is expressing somebody else's intentions makes editing terms superfluous. In speech, utterances are not only evaluated in terms of linguistic rules, but also with respect to their conversational aspects (e.g. a word may be evaluated for its appropriateness). In reading, there seems to be only one type of error: 'I did not read what is written on the paper!'. The expressed intentions need not be nuanced or commented on.

That poor readers said 'nee' ('no') or 'oh nee' ('oh no') several times can be explained by the specific trouble which a poor reader has. He makes a lot of errors. Being aware of this, he tries to convince the experimenter that it is not as bad as it seems. Perhaps one way of keeping up a good impression is the expression of 'Oh no' after the detection of an error. This expresses something like: 'Look, I know very well that this is wrong' or 'Even I know better than that.'

The main conclusion is that editing terms are not important in reading. This testifies to a pragmatic function in speech for these terms, such as expressing what the status of the correction is or to prevent interruption by the interlocutor.

4.3 The restart

The third part which is of interest in the realization of a self-correction is the point where the utterance is restarted. If a self-correction is realized, a speaker does not always start at the point where the error occurred. Often the restart is one or more words before the point where the error occurred: the span of retracing (see example [4.3] and [4.4]).

(4.3)	Span of retracing 0		
	T	En hij deed alsof *het*	een heel gewone dag was.
	R	En hij deed alsof *hij ... het*	een heel gewone dag was.
	ET	And he acted as if *it*	was just an ordinary day.
	ER	And he acted as if *he ... it*	was just an ordinary day.
(4.4)	Span of retracing 2		
	T	'Het zijn beste dieren', zei de *boer*	tegen de boerin.
	R	'Het zijn beste dieren', zei de *boerin ... zei de boer*	tegen de boerin.
	ET	'They are nice animals', the *farmer*	said to his wife.
	ER	'They are nice animals', the *farmer's wife ... the farmer*	said to his wife.

The reason for going back to a point before the error may be to preserve a structure which is understandable to the listener. If an error occurs, the speaker has to make clear which part of the preceding utterance has to be considered correct and which part has to be replaced by the correction. It is even possible to formulate a grammatical framework in which a self-correction has to fit in order to be a well-formed self-correction. The well-formedness rule formulated by Levelt leans heavily on the grammatical principles that govern coordination. It is formulated as follows: 'A repair <A,C> is well-formed if and only if there is a string B such that the string <AB *and* C> is well-formed, where B is a completion of the constituent directly dominating the last element of A. *and* is to be deleted if C's first element is itself a sentence connective)' (Levelt, 1983; p. 78). The rule accounts for the finding that retracing shows a tendency to start at constituent boundaries. It turned out to be difficult to prove that this finding is of interest for the way in which errors are corrected. The chances that a restart coincides with the beginning of a constituent are very high in right-branching languages like Dutch. Although a lot of retracings start at the beginning of constituent boundaries it could still be the case that the grammatical structure of the target sentence only plays a minor role in the correction of the error. However, the fact that the well-formedness rule holds, is a strong indication that the grammatical structure – and thus the beginnings of constituents – plays an important role in the realization of a self-correction.

The analyses presented here do not aim at testing or even applying the well-formedness rule in reading. It is very difficult to decide whether self-corrections as investigated in this study are well-formed according to Levelt's rule, because the poor readers produce utterances with a lot of uncorrected errors; the part before the error is often ill-formed. Nor is it the aim of the present analysis to investigate whether retracing is correlated to the error in the same way as the delay of interruption is.

The purpose of the present analysis is to verify the finding of the previous chapter that good readers show better use of the syntactic and semantic structures in their correction behaviour than poor readers. If the structure of the sentence plays a role in the decision where to restart, this structure must be available to the language user. Differences in restarting between good and poor readers can thus be expected on the basis of the differences found in the previous chapter.

The good readers returned to a point one or more words before the erroneous word in 41.1% of their self-corrections (N = 214). Poor readers returned in 14.8% of the cases (N = 325) to a point before the error $t(40) = 12.82$, $p < .001$, two-sided). An overall picture of the frequencies of the different length of retracings for the two groups of readers is presented in Table 4.8.

readers	span of retracing					
	0	1	2	3	4	5	>=6
good readers	141	43	17	21	11	3	5
poor readers	277	21	12	8	2	1	4

Table 4.8 Distribution of the various lengths of retracings in the realisation of self-corrections. (analyses XIV - XVII)

In order to investigate whether retracings are at least partly dependent on the target structure, an analysis was carried out to investigate whether the decision to retrace one or more words is correlated to the position of the error in the sentence. The initial analysis focussed on the beginning of the sentence as the restarting point. Subsequent analyses also took points into consideration that were situated further on in the sentence structure.

An important motive to investigate the beginning of the sentence is the finding that retracings hardly ever cross a sentence boundary. Of the 148 self-corrections that were restarted at some point before the error only 1 seemed to start in a preceding sentence. This self-correction happened to be a very complicated one with a number of attempts at the same target word.

Analysis XIV: retracing and position in the sentence. To determine the role of sentence beginnings in the restart procedure the position of the erroneous word is determined. Only erroneous words in the range between the second and seventh position in the sentence were admitted in the analysis. For errors in position 1 the span of retracing is almost by definition 0. Errors in position 8 and more have a very high chance of belonging to a different clause than the one with which the sentence started. The beginning of a sentence and a clause share many structural properties, so it was decided to disregard the correction of those errors.

Data. For every position in the sentence, the frequency of retracings greater than 0 was divided by the number of self-corrections that were realized in that position by that reader. This score will be called the *retracing proportion.*

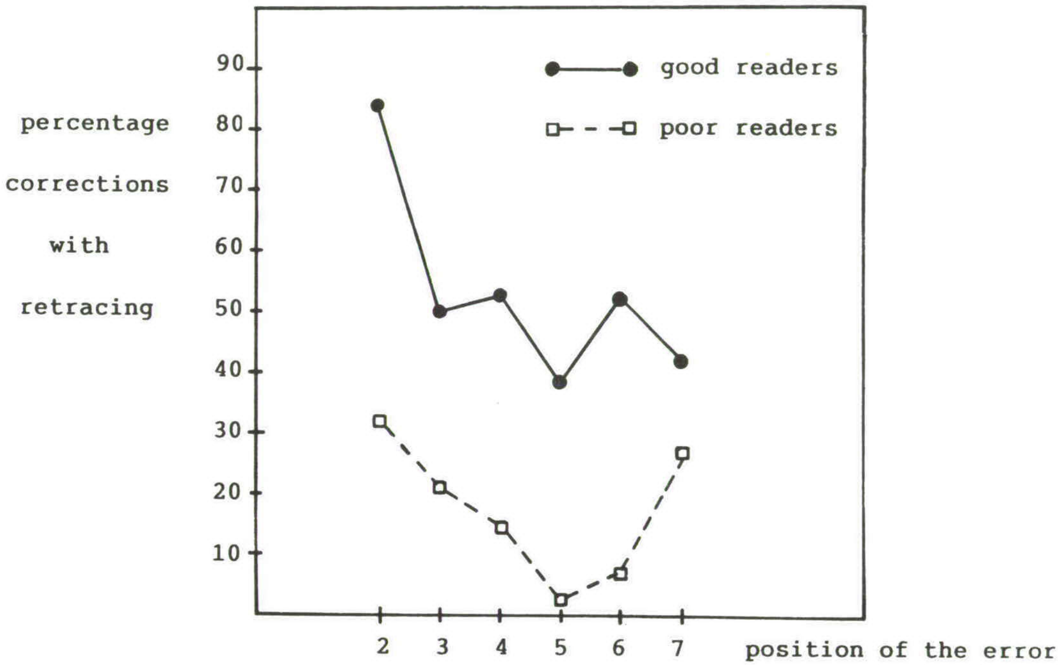

Figure 4.1 Relation between the position of the error in the sentence and the span of retracing. (analysis XIV)

Expectations. Since the beginning of a sentence might be a preferred place to restart, the retracing proportion will decrease when the error occurs later in the sentence.

Results. The good readers showed a statistically significant negative correlation between retracing proportion and the position in the sentence $r = -.40$, $p < .01$). This means that the proportion of corrections with a span of retracing greater than 0 decreases as the reader progresses in reading the sentence. Or, to put it differently, the closer one is to a sentence beginning, the more often a retracing to a point before the error (probably the sentence beginning) is realized. The data for the poor readers showed the same negative correlation $r = -.34$, $p < .01$).

The data are presented in Figure 4.1. As can be observed in Figure 4.1 the good and poor readers show fairly similar behaviour in retracing with respect to the position in the sentence. At least errors at position 2, 3, 4 and 5 show a clear tendency to decrease in the proportions of the retracings and this decrease leads to the negative correlations that are found. This decrease is not merely interpreted as a positional effect, but rather as a structural effect: if the beginning of an important grammatical structure is nearby the tendency to go back in realizing a self-correction is strong. In other words, the beginning of a sentence structure may be a favoured place to start a self-correction.

Analysis XV: retracing to the beginning of the sentence. To prove that the beginning of a sentence is a preferred place to start a self-correction, it should be demonstrated that the readers go back to those beginnings more often than might be expected if the retracings were realized arbitrarily with respect to the beginning of the sentences. The number of times that a subject restarted at the beginning of a sentence may be called the '*realized* structural restart score'. The probability of restarting at the beginning of a sentence if the restarting behaviour is not influenced by those sentence beginnings may be estimated. This estimate can be called the '*estimated* structural restart score'. The *estimated* structural restart score is computed separately for the various positions of the errors in the sentences and the size of the various spans of retracings, as will be explained below.

Data. For every corrected error the span of retracing as well as its position in the sentence was available from analysis XIV. Only the self-corrections for which the position was 2 or more were subject to analysis. Only those self-corrections whose span of retracing was equal to or greater than 1 word were subject to analysis.

The number of self-corrections for which the position was equal to the span of retracing plus 1 (the self-corrections restarting at the beginning of the sentence were thus selected) was divided by the total number of self-corrections. The outcome of this calculation, carried out separately for each subject, is the *realized* structural restart score.

The calculation of the *estimated* structural restart score is done as follows. The probability (p) that a restart of (n) words falls at the beginning of a sentence for a particular subject is: the number of corrected errors on the position (n) + 1 in the sentence divided by the total number of corrected errors. The number of restarts of a given length that will be at the beginning of a sentence will be the chance (p) multiplied by the number of the retracings realized. To give an example: if a certain subject made 5 retracings of 3 words in the sentence, the number of times those retracings would start at the beginning of a sentence by chance would be 5 times the number of errors he made at position 4 divided by the total number of corrected errors. The estimated structural restart score, then, is the sum of all the chances for the various lengths of the retracings of one subject. So if a subject realizes 4 errors with a span of retracing of 1 word and 3 errors with a span of retracing of 2 words, the calculated score is the sum of 4 times the chance that he would start at the beginning of a sentence realizing a span of retracing of 1 word arbitrarily and 3 times such a chance in the retracing of 2 words. By calculating the *estimated* structural restart score in this manner, differences between subjects with respect to the positions of words which are corrected are taken into account. Moreover, differences between subjects in the distribution of the number of words retraced are also taken into account.

Expectations. The *realized* structural restart is higher that the *estimated* structural restart. The difference between the two scores is greater for good readers than for poor readers.

Results. The mean *realized* structural restart score for good readers was 16.9%. The mean *estimated* structural restart score for those readers was 12.0%. The mean *realized* structural restart score for poor readers was 16.7% and their *estimated* structural restart score 13.1%. An analysis of variance was carried out with the subjects as random factor. There was one within-subjects factor, the structural restart score (levels: realized and estimated), and one between factor, the group of reader (levels: good and poor). The difference between the *realized* and *estimated* structural restart score was significant $F(1,40) = 6.29$, $p < .02$, one-tailed). The difference between the good and poor readers as well as the interaction between the two factors was not significant.

The results showed that both good and poor readers have a tendency to start at the beginning of a sentence. That no difference could be found between the two groups can be explained by the recognizability of the beginning of a sentence. Going back in order to find the beginning of a sentence, one can use not only the syntactic structure but also the full stop at the end of the previous sentence and the capital letter at the beginning of the current sentence. Moreover, the syntactic analysis necessary to decide where the sentence begins is not very complicated. It was therefore decided to investigate other types of important grammatical points which could be assumed to be preferred as restarting points when realizing a self-correction.

Analysis XVI: retracing to the beginning of the sentence and the clause. Not only the beginning of a sentence was considered to be a preferred place to trace back to, but also the beginning of clauses. Although partly recognizable by the occurrence of a comma, the identification of the beginning of a clause seems to be more subtle than the identification of the beginning of a sentence. It was assumed that good readers would be more successful than poor readers in retracing to syntactic boundaries that are difficult to recognize.

Data. In the present analysis the position of the corrected error in the sentence was recalculated if the beginning of a clause preceded the error. In other words, the position of the error was specified with respect to the beginning of the clause in which the error actually occurred. In a number of cases this position was not changed, i.e. whenever the beginning of the clause coincided with the beginning of the sentence. The same procedures were followed as in analysis XV to calculate the new *realized* structural restart score and the new *estimated* structural restart score for every individual subject.

Results. The good readers showed a mean *realized* structural restart score of 30.7%. Their mean *estimated* structural restart score was 19.3%. For the poor readers these figures were 23.8% and 18.0% respectively. An analysis of variance (the same design as in the previous analysis) showed a significant difference between the *realized* and the *estimated* score $F(1,40) = 21.60$, $p < .01$). The difference between the good and poor readers was not significant nor was the interaction between the two factors (although a very weak tendency could be observed: $F(1,40) = 2.28$, $p = .13$).

The results clearly show that good as well as poor readers tend to restart in the realization of a self-correction at the beginning of a sentence or clause. Although not significant, there seems to be a difference between good and poor readers in the amount of retracing to grammatically interesting points. A clear difference between the two groups of readers might be found if places that are syntactically more subtle were investigated as potential tracing points.

Analysis XVII: retracing to the beginning of the sentence and ***clause and to the beginning of a noun phrase or prep phrase.*** In this analysis it was assumed that not only the beginning of a sentence or clause is a preferred place to restart but also the fairly simple recognizable beginning of a certain type of noun phrase (NP) or prepositional phrase (PP). The NP in question had to start with an article. The PP had to start with a preposition followed by an article. The NP and PP were to end with a noun and could contain modifiers (adverbs, adjectives or nouns).

Data. The position of the error was recalculated if the error occurred in a NP or PP of the type described before. The position in those cases was relative to the beginning of the phrase boundary, i.e. relative to the preposition or the article. The calculation of the two structural restart scores per subject was carried out in the same fashion as in analysis XV.

Results. The good readers showed a mean *realized* structural restart score of 54.1% and a mean *estimated* structural restart score of 33.0%. For the poor readers these percentages were respectively 35.7 and 30.9. An analysis of variance (the same design as in the previous two analyses) showed a significant difference between the *realized* and the *estimated* scores $F(1,40) = 32.43$, $p < .01$). This difference was significantly greater for good readers than for poor readers $F(1,40) = 12.71$, $p < .01$).

Good readers show a clear tendency to restart a self-correction at the beginning of a sentence, clause or phrase. Poor readers also show a tendency to restart at important points in the structure (analyses XV and XVI). They are, however, not so successful in achieving this goal when the structural point is more difficult to distinguish, i.e. mainly on the basis of purely syntactic analyses and not on the basis of punctuational information.

Discussion and conclusions. After the detection of an error a reader must decide how to correct it. Like the correction of a speech error, the correction of a reading error does not simply start with the correct version of the erroneous word. In a number of cases it is appropriate to start the actual correction at some point before the incorrect word. To find such a point, some information about the structure which precedes the error must be available. Both good and poor readers tend to go back to the beginning of important constituents in the syntactic structure of a sentence. The beginning of a sentence or clause are such favoured points for starting a correction. The beginning of constituents which form subordinate nodes within the complete structure of the sentence (like NPs or PPs) also seem to be used as starting points by the good readers. Poor readers, on the other hand, fail to use these beginnings. This suggests that poor readers are not able to use the information concerning syntactic structures to the same extent as good readers are. This finding is in line with the findings in the previous chapter: poor readers are not as proficient as good readers in the use of contextual information.

4.4 The correction behaviour of poor readers

Poor readers show correction behaviour that is very similar to that of good readers. Differences in correction behaviour can be explained to a great extent by the decoding problems after the detection of errors by poor readers rather than by failures of the error detection mechanisms. Moreover, the enormous amount of errors, and of errors that can not be corrected in spite of detection, may discourage the poor reader from starting new corrections (in absolute terms poor readers correct more errors than poor readers). The similarity in correction behaviour of poor readers and good readers follows also from the information sources used to detect errors. A number of different types of linguistic information proved to play the same role in the detection and correction of errors for both good and poor readers. This similarity in behaviour is not very curious; it is not unusual that a reading pattern which is considered to be specific to a poor reader in the end turns out to be within the range of the great and systematic individual differences that can be found when a careful comparison is made with respect to the reading behaviour of a normal group of readers (e.g. Bryant and Impey, 1986).

However, good and the poor readers differ in correction behaviour with respect to use of context. A poor reader uses the context less than a good reader to detect his errors (as shown by the detection incidence, and the moment of interruption), and in deciding where to restart for correction.

That poor readers have problems in using the *syntactic* context is in line with the findings of such investigators as Guthrie (1973), Cromer and Wiener (1966) and Oaken, Wiener and Cromer (1971). As far as the use of *semantic* context information is concerned, the finding that poor readers have problems in this respect (e.g. Pflaum & Bryan, 1980) is at variance with the results of other studies, e.g. Allington and Strange (1977), Biemiller (1977-1978, whose subjects are, however, low-ability readers) and those of Perfetti and his associates (Perfetti, Finger, & Hogaboam, 1978; Perfetti & Roth, 1981). There are also studies that show efficient use of both the syntactic and semantic context by poor readers (e.g. Allington & Fleming, 1978). The *verbal efficiency* theory – discussed below – accounts for most of these findings.

One group of researchers which performed a lot of experiments on the use of context in word-identification is Perfetti and his colleagues in Pittsburgh. Two results are of interest for the present study: first, low-ability readers are helped more by context than high-ability readers (Perfetti, Finger, & Hogaboam, 1978), and show greater inhibition effects when words are presented in an anomalous context (Perfetti and Roth, 1981). According to West and Stanovich (1978) a similar difference in context effect between adults (more proficient readers) and children (less proficient readers) can be shown: there are only inhibition effects for children. Second, low-ability readers are less accurate in predicting words on the basis of the preceding context (Perfetti, Finger, & Hogaboam, 1978). The second finding is not incompatible with the first finding: the first is based on a situation in which context information is available and the second presupposes that this information has to be generated. When low-ability readers have context information at their disposal they are good at using it. However, these readers have problems in generating that context information. Due to a poor functioning of low-order local processes (e.g. inefficient lexical access), the processes which handle context information cannot work properly. This theory of *verbal efficiency* – for a detailed explanation see Perfetti, 1985 – states that individual differences in reading depend critically on the assembly and integration of various types of linguistic information. Lexical access, for instance, should be performed by a process which is efficient, rapid and low in resource cost, otherwise two problems can arise: first, inefficient access interferes with higher order processes or second, inefficient lexical access produces low-quality codes (this so-called *lexical access hypothesis* is investigated in Lesgold and Perfetti, 1978; Perfetti, 1977; Perfetti and Hogaboam, 1975; Perfetti and Lesgold, 1977).

The most important assumption of the *verbal efficiency* theory is that inefficiency of low order processes can lead to problems in higher order processes because some mental processes operate under limitations imposed by system constraints, viz. a limited-capacity working memory system. Thus, an experienced and good reader can use a number of processes which carry out various encoding tasks automatically and which demand a relatively limited supply of cognitive resources (LaBerge & Samuels, 1974).

Perfetti and his colleagues assume that the processes that have to do with integration of context information work perfectly in low-ability readers and that these readers use this information even to a greater extent than high-ability readers. High-ability readers are so fast that they cannot employ all the context information that becomes available at a rather slow rate in the course of word recognition. This would explain why they do not show inhibition effects when reading words in anomalous contexts. However, in spite of the ability of poor readers to use context information very well, they will meet problems in using this information during normal reading since the inefficient lower order processes will take most of the mental resources and leave the reader with an incomplete and poor context.

The current findings fit within these theories: poor readers meet so many problems in decoding the written material that the processes which handle context information cannot work optimally (see e.g. Daneman & Carpenter, 1983; Graesser, Hoffman, & Clark, 1980; etc.). Since the error detection mechanisms are supposed to work at the outcome of these processes it is logical to find a relatively low number of detections on the basis of these processes. In this situation the error detection mechanisms do not have much context information at their disposal. However, the research presented so far is not conclusive with respect to the use of context in error detection by poor readers. Although it seems reasonable to assume that a low-order decoding process causes little context information to be generated, it may still be the case that contextual information does indeed play a different role in the error detection of poor readers. In chapter 6 and 7 this question will be investigated further .

Chapter 5 Problems with the interpretation of errors.

In the previous chapters the role of several sources of linguistic information in the detection of errors was evaluated. One outcome (analysis VII) was difficult to interpret. The number of linguistic sources which could be used to detect an error was not highly correlated with the detection chance. Two explanations can be postulated for this finding that an increase in the number of indications that something must be wrong does not lead to an increase in the number of detections. First, it is possible that this finding is the result of the way errors are detected. Then, error detection is organized in such a way that only one source of information at a time may play a role in it. This is not very likely. It would mean that information is lost. The second possibility is more likely: the way the errors are classified in this study is the reason why no high positive correlation can be found between the number of sources for error detection and the incidence of detection. Two types of wrong analysis can be distinguished. First, analyses to measure single sources of information for error detection actually measured the effects caused by several sources. Second, analyses to measure several sources measured effects which were in fact due to one source.

The next part of the present chapter consists of an analysis of the inter-relationship of several types of linguistic information in the classification of the error collection. This inter-relationship means that errors which seem to be detectable on one source of linguistic information, are actually detectable on the basis of a number of sources. In a subsequent part, evidence from the observed errors and one experiment will be presented to make a reasonable case for the claim that errors sometimes suggest more trouble - and hence more detectability - than is justified. This suggests that errors which seem to be detectable on the basis of a number of errors are in fact only detectable on one source.

5.1 The overlap between linguistic classifications of errors

In order to determine the role of two linguistic sources of information in the detection of errors, these sources should be independent to a certain extent; there should be some errors where one of the two sources provides information for the detection mechanisms while the other does not. Some types of linguistic information, however, are so closely connected to each other that success or failure with respect to one type has to entail - almost by definition - the success or failure of the other type of information.

Every reading error in this study shows a discrepancy between the letters on the paper and the sounds produced. In other words there is always a difference on the grapho-phonemic level when the written word is compared to the error that is produced. This difference can always be used as information to detect errors. Every error also contains at least one discrepancy between the realized word and the target word with respect to another type of information (viz. word class and/or word meaning). So every error on the phonemic level is also detectable on the basis of at least one other source of linguistic information.

Errors with respect to syntactic information often affect the semantic information. Although it is possible for a sentence which is syntactically incorrect to be understood, i.e. a coherent meaning can be derived, it may be claimed that nearly always some subtle semantic details are lost or changed if the syntactic structure is changed. A high overlap between syntactic and semantic appropriateness is often found in studies on reading errors (e.g. Kolers, 1970; Weber, 1970a).

The amount of overlap of several sources of information for the detection of substitution errors can be computed. For every type of linguistic information, each error is classified as either providing information for detection or not. The information for detection based on the discrepancy between error and target word and the information for detection based on the impossible linguistic structure of the error were studied in one analysis. By means of this classification it is possible to calculate for a given type of linguistic information to what extent other types of information support or contradict the detection-information.

	word class	word meaning	morph. stems	morph. affixes	syntactic context	semantic context
good readers						
word class	100	67	82	24	45	46
word meaning	75	100	89	20	41	47
morph.stems	64	80	100	15	38	43
morph.affixes	43	43	39	100	40	44
syntactic context	63	72	80	33	100	100
semantic context	57	72	81	31	88	100
poor readers						
word class	100	74	79	29	67	69
word meaning	79	100	89	26	60	66
morph.stems	75	93	100	24	58	63
morph.affixes	44	48	47	100	57	59
syntactic context	73	80	82	41	100	100
semantic context	70	81	83	40	93	100

Table 5.1 The interrelation between the various types of errors (given in vertical direction) and the percentages of incorrectness with respect to the other types of information (given in horizontal direction). (corpus of errors and corrections)

In Table 5.1 the amount of overlap is presented for 6 sources of information (the source letters/sounds is left out because every error is also incorrect with respect to the realized letters). For example, of the errors which are detectable on the basis of their word class, 67% are also detectable on the basis of the meaning while 45% are detectable on the basis of syntactic context etc. The main conclusion which can be drawn from the data presented in Table 5.1 is that the types of linguistic information used for the detection of errors are, to a large extent, intertwined.

The earlier suggested solution to the analytical problem is to keep the information provided by 6 linguistic sources constant and then decide whether a change in the 7th source of information leads to a change in the number of detections or self-corrections. As said before, this approach is not possible for the information concerning graphemes/phonemes, because this information plays a role in every error. But for the other types of information also this solution does not work. The number of observations of undetected and detected errors for each individual subject are too small if the basis for detecting the error has to be ascribed unambiguously to one particular linguistic source. The conclusion is that it is hard to isolate the specific role of one type of linguistic information in the production or the detection of errors on the basis of a collection of errors and corrections.

5.2 Experiment I

This section discusses research on the question of whether the analysis of the error gives a correct indication of the information that is available to the reader. The assumption is that errors do not always reflect exactly what went wrong because information which is processed correctly can be covered by an error which occurs in a later process. This means that much correct information can be available in spite of a completely incorrect surface form. In the following an example will be given from the corpus of errors and corrections to illustrate this. Subsequently, an experiment is presented to test whether information is absent or available in spite of the correct or incorrect reading of a word.

In order to show that much correct information is available even if an error is produced, errors on a specific target word are inspected more closely. In the text that was read by the good and poor readers the word 'het' appeared a number of times. In Dutch the word 'het' may be a definite article (the form which is used for neuter nouns) or a pronoun (*it*). The function of this word becomes clear from the context and obviously cannot be inferred from the surface form (the letters). The good readers made 15 errors on 'het' if it was the definite article and 11 if it was a pronoun. The poor readers made 21 errors on the article 'het' and 23 on the pronoun.

readers	function of *het* in the text	the nature of the error is article-like	pronoun-like	otherwise
good readers	article	11	2	2
	pronoun	1	5	5
poor readers	article	14	2	5
	pronoun	1	12	10

Table 5.2 The types of errors on the word *het*. (experiment I)

In Table 5.2 the numbers are given of those instances where the error was 'article-like' - i.e. the indefinite article 'een' (in English: a/an) or the demonstrative pronoun 'die' (in English: *that*) - or a pronoun, i.e. the personal pronoun 'hij' or 'zij' (in English: *he* or *she*). The errors clearly show that the knowledge of whether the target word had to be an article or a pronoun was available in most cases ($\chi^2(1) = 8.15$, $p < .01$ for good readers, and ($\chi^2(1) = 18.24$, $p < .001$ for poor readers). If errors are made which bear such a clear relationship to the target word, it may be assumed that, in spite of the error, at least some correct information about the target word is processed and used in the productional stage.

A very important type of information is the meaning of a word. To be able to observe what information is available with respect to meaning, subjects were asked for this information after reading a number of target words. The question: 'What is the meaning of the last word you read?' is not, however, a simple one to answer. A definition is difficult to produce, and may be hard to evaluate. For the poor readers in particular the question is too difficult. It was therefore decided that the subject only had to make a restricted choice. After reading a target word the question was: 'Does the last word you read have something to do with ...?' Four alternatives were presented after this question by the experimenter. One of the alternatives bore a clear semantic relationship to the target word the reader had read.

The points of interest were: (i) the number of times an incorrect choice was made with respect to the meaning of a word in spite of the fact that the word had been read correctly, and (ii) the number of times a correct choice was made in spite of the word being read incorrectly. Assuming that the way in which a word is read does not always reflect the information available, the following hypothesis are made: If a word is read correctly, then not all choices in answering the question "Does the last word you read have something to do with ...?" are made correctly; if a word is read incorrectly more choices are correct than would be statistically expected. Since poor readers make more errors than good readers these effects will be greater for them. Furthermore, the good readers will, of course, make less errors and more correct choices than the poor readers.

The information about lexical word meaning can become available through the recognition of a word on the basis of the letters. But much information can also be inferred on the basis of the context. Contextual information can lead to the situation that although a word is read wrongly, correct information about its meaning and syntax is nevertheless still available. In order to know more about the role of contextual information, the experiment involved target words presented in sentences as well as in isolation.

5.2.1 Method

Material. Two sets of sentences, A1 and B1, were selected for the experiment. A revised version was derived from each set. These revised versions, A2 and B2, were constructed by deleting all punctuation marks and listing the words in a random order. Then, two experimental lists were prepared. The first consisted of sets A1 and B2, while the second consisted of A2 and B1. At the beginning of both these experimental lists, ten practice sentences were included.

In both experimental lists 25 words (nouns and verbs) were the target words. For every target word, one word was chosen related to the target, along with three unrelated words. These four words were used in the question asked after each target word was read. There were targets and correct choices closely related in meaning (e.g. 'planks' as target word and 'beams' as related word), but also target words which were members of the class denoted by the related word (e.g. 'sparrow' as the target word and 'bird' as the related word) or the term for the agent who typically perform the action denoted by the verb (e.g.

'to bark' as the target word and 'dog' as the related word).

Subjects. The good readers were 14 pupils of two primary schools. The poor readers were 14 pupils of two LOM schools. The mean age of the good readers was 11 years and 2 months and the mean age of the poor readers was 10 years and 4 months. The poor readers were selected by the teachers according to the criteria given in chapter 1. A reading test (Dommerholt, 1970) was also administered: the good readers showed a mean score of 56 (sd. 2.8) and the poor readers had a mean score of 28 (sd. 25.3).

Procedure. The subjects were instructed to read the experimental sentences and words aloud and to stop immediately if the experimenter told them to. Furthermore they were told that after they had stopped, a question would follow about the meaning of the last word read. The experimenter monitored the reading and if a target word was read aloud, he said 'stop', covered the text or words with a sheet of paper to prevent rereading of the target word and asked: 'Does the last word you read have something to do with ...' followed by the four alternatives. When the subject had made his or her choice the reading was continued with the beginning of the sentence in question or the next word in the word list. After the instructions the subjects read 10 sentences to practise. Then, one of the experimental lists was presented. Every session was rounded off with the reading test mentioned above. The whole session was recorded on tape in order to make accurate judgments of the reading of the target words possible.

5.2.2 Results

The good readers made only very few errors on the target words they had to read. For these readers there were only sufficient observations for the correctly produced target words to study the choices with respect to the meaning-related words. The poor readers made a considerable number of errors on the target words. For them the proportion when a correct choice was made with respect to the meaning-related word was calculated for both the correct and the incorrect realization of the target word. The results are presented in Table 5.3. The manner of presentation (words in a sentence versus in isolation) had no impact on the number of errors made by the readers. The same holds for the choice of semantic alternatives. Therefore, this difference will be ignored in the following statistical analyses.

In the case of the correct realization of a target word the good readers chose the correct semantic alternative in significantly fewer cases than expected ($\chi^2(1) = 41.18$ $p <.001$). In fact, a 100% score could have been expected. The number of errors made on the target word by the good readers was too small to achieve a reliable estimate of the number of good choices made after the occurrence of an error. The poor readers chose the correct alternative after a correct realization less often than expected ($\chi^2(1) = 77.58$, $p <.001$). If they made an error, they chose the correct alternative in significantly more cases than chance would allow (4 alternatives, 25%; $\chi^2(1) = 11.23$, $p <.001$). The good readers made fewer errors than the poor readers with respect to the target words ($t(26) = 6.02$, $p <.001$, one-tailed). The groups also differed in the proportion of incorrect choices in the case of a correct realization ($t(26) = 2.34$, $p <.02$, one-tailed). A comparison between the groups in terms of a correct choice after an incorrect realization was not possible.

readers	reading of the target	choice of the related word: correct		incorrect		Total
target words presented in sentences						
good readers	correct	327	(94%)	22	(6%)	349 (100%)
	incorrect	0	(0%)	1	(100%)	1 (100%)
poor readers	correct	289	(89%)	34	(11%)	323 (100%)
	incorrect	13	(48%)	14	(52%)	27 (100%)
target words presented in isolation						
good readers	correct	331	(95%)	18	(5%)	349 (100%)
	incorrect	0	(0%)	1	(100%)	1 (100%)
poor readers	correct	257	(87%)	39	(13%)	296 (100%)
	incorrect	28	(52%)	26	(48%)	54 (100%)

Table 5.3 Correct choice (out of 4 alternatives) of a word related in meaning to the target word after the reading of this target word. (experiment I)

5.2.3 Discussion

If a target word was read correctly, a number of times both the good and the poor readers chose a wrong alternative. If the poor readers read a target word incorrectly, the right alternative was still chosen in about 50% of the cases. These findings have to be compared to the expected choices (100% and 25% respectively). However, the relationship between some target words and their related alternatives may have been somewhat unclear. In this case, the fact that the good readers did not choose the correct meaning-alternative in 100% of the cases would not be very informative. But the finding that poor readers perform worse if they have to choose a semantic alternative after having read a target word successfully is relevant. They have less semantic information available than the good readers. However, it has to be checked whether the expected choices were estimated correctly.

The four alternatives for some of the target words could have been chosen in such a way that, even if a choice was made without considering the target word, a preference for the correct alternative existed. A test was carried out to assess the chance of choosing the correct meaning-alternative. An investigation was made to see if the high number of correct choices of the poor readers was based on the way they read the target word or merely on properties of the alternatives.

A group of good readers (N = 14) and a group of poor readers (N = 14) were selected using the same criteria as in experiment (I). The children had to choose the correct semantic alternative for every target word. Half of the target words were presented together with the same alternatives as in the previous experiment. Half of the target words were related arbitrarily to a set of four alternatives belonging to another target word. The target word and the alternatives were presented orally in the question: 'Does the word ... (target) have something to do with ..., ..., ... or ...' In order to collect data on all the target words in combination with both the original alternatives and with a randomly selected set of alternatives, two lists were constructed. If a target word was presented with the original alternatives in one list, it was presented with a randomly selected set in the other list. Half of the subjects were presented with the one list and the other half received the other list. The children were told that although it would sometimes be difficult to make a choice, such a choice had to be made every time.

The good readers chose the correct alternative in 99% of the cases where the correct target word was presented with the appropriate set of alternatives. If the target word was coupled to a randomly selected set of alternatives, these readers chose the alternative which was considered correct for another target in the experiment in 28% of the cases. For the poor readers these figures were 97% and 23% respectively. On the basis of this control experiment it was concluded that the expected chances of choosing the correct alternative (100% and 25%) were estimated correctly in the analysis of experiment (I).

From experiment (I) it may thus safely be concluded that the number of correct alternatives chosen by poor readers after an incorrect reading is higher than chance would allow. Whether this discrepancy between the meaning that is accessed and the phonological representation of the word that is produced stems from the decoding activities or from the production activities is not clear. There is some evidence that phonological recoding is on the average slower than visual coding which leads directly to semantic access (Singer, 1980; Stanovich & Bauer 1978). Other investigators, however, have reported an advantage for regular words, suggesting that phonological recoding may be faster than visual coding (Parkin, 1982; Parkin & Underwood, 1983). Both findings may be considered consistent with the results of experiment (I): it is possible that the semantic information is available at a different moment than does the phonological information. On the other hand, it is possible that a problem in the production causes the discrepancy between the availability of meaning and word form. This type of trouble can be compared to the 'tip of the tongue' phenomenon (Brown and McNeill, 1966). In such a situation a speaker has a very clear image of the word to be expressed (even partial information about the word form: "It begins with an 's'") but is unable to find the complete word form.

A discrepancy between the meaning that is accessed and the phonological representation of the word that is produced was also observed in a small number of errors. One target word was 'planken' (*shelves*). Poor readers produced a number of times the errors 'balken' (*beams*) as well as 'latten' (*slats*), which both are semantically related to the target word. This 'deep dyslexia-like' phenomenon can be specific for poor readers: although one type of information is available (meaning) the corresponding information of a different type (the word form) cannot be made available - poor readers seem to have an extremely loose connection between the different linguistic information sources.

That the errors where the meaning was accessed correctly were not corrected overtly may be explained by spontaneous covert corrections. Some studies provide fairly strong evidence for the spontaneous rectification of certain types of errors, e.g. mispronunciations. That phonological errors can be corrected - in an automatic way - in the recognition of words is demonstrated by experiments in which subjects had to carry out a shadowing task (Marslen-Wilson & Welsh, 1978; in Cohen, 1980, the subjects were even explicitly instructed not to restore the errors).

One of consequences of the finding that a reading error does not always mirror the faults in the processing of the word is that a miscue analysis in order to find the specific weaknesses of a poor reader is dubious. Another consequence is that findings based on the analyses of the errors have to be re-evaluated. In the next section the investigation of the collection of reading errors and self-correction will be subject to final discussion and conclusion.

5.3 Error and self-correction collection: discussion and conclusion

Several types of linguistic information can be used together to correct most errors. This causes real problems in deciding how and when errors are detected. (Multiple-source errors lead to interpretation problems for all kinds of inferences made with respect to errors, as pointed out by Leu, 1982.) The conclusion then is that it is not possible to pinpoint the exact role of each source of information. Experiments in which one source of information is varied systematically, while other possible sources for error detection are kept constant, seem to be the only solution.

When a reader makes an error, there can be a discrepancy between what he reads aloud and what is mentally available to him (experiment [I]). This means that an error-based analysis, such as the one carried out, which overlooked that discrepancy, is not entirely accurate. However, such analyses do in fact make sense. To explain this, it is necessary to examine further the outcome of experiment (I). Two observations were made: information that seems to have been processed wrongly (in the sense that the target word was read incorrectly) was in fact available when it had to be used in answering the question asked during the experiment and, second, information that seems to be correct (in the cases when no error was made on the target words) was not always employed correctly if it had to be used to answer the question. For the first finding there seems to be no explanation other than the one discussed so far: the information is processed correctly in spite of the error. The finding that if the target word was read correctly, this did not always lead to a correct answer to the question of which of the presented words was semantically related, may be partly explained by the load that the reading task puts on the system. For instance, it may not always be clear to the subject what the last word was: information concerning other words may be processed during the pronunciation of the target word. Moreover, if the target word was read correctly the answer to the question was correct in the great majority of the cases. At least the good readers' score was as high as 95 percent or more. This means that reading a word correctly with respect to meaning means in only a very few cases that the information is not available correctly to the system. Evidence for this also stems from the correction behaviour in the collection of errors and corrections: words that are realized correctly are hardly ever further amended 'incorrectly'.

It seems safe to assume that the information which is not incorrect in an error is nearly always processed correctly, whereas information that is incorrect – at least as far as can be inferred from the error – is processed partly incorrectly and partly correctly. This leads to the following interpretation of the findings in chapters 3 and 4. Those features of an error that were correct could not have been used to detect the error. Those features which happened to be represented incorrectly in the error could have been used to detect the error. The latter is only true in a number of cases: there is also a proportion of cases in which the information was, in fact, correctly processed and thus could not be used to detect the error. It seems to be reasonable to assume that the findings would have been clearer – and in the same direction – if the errors had reflected better the trouble that occurred within the language system.

Two main conclusions on the processes of error detection may be drawn from the investigations of the collection of errors and corrections: one concerns the sources of information used to detect errors and one concerns the detection mechanisms. It may be claimed that more than one source of linguistic information plays a role in the detection of errors. If a reader used only one source of information, like the semantic coherence of the material he is reading, it is most improbable that any effect resulting from the discrepancy between the letters and the sounds would be found. However, both semantic and letter/sound information are used for error detection. Although the sources of information are correlated to a great extent, this does not hold for all sources, and neither does this inevitably lead to the identification of one particular source as the main source of information for error detection.

Two types of error detection mechanisms seem to play a role in the realization of an error-correction. The existence of an error detection mechanism based on the *no result error detection* mechanism follows from the detection of errors that consist of nonwords or other linguistically unacceptable structures. It is impossible to compare linguistic information such as, for instance, the word class and word meaning of a nonword with that of the target word, since no word class and meaning can be assigned to a nonword. In spite of this, it was found that these errors were corrected. Thus, the absence of word class and word meaning must be used to detect those errors: the *no result error detection* mechanism. The other type of error detection mechanisms, the *double* and *two way error detection* mechanisms follow from the detection of errors that are correct as far as certain linguistic rules are concerned. The detection of these errors must be based on mechanisms which make a comparison between the produced word and the word which was read.

The main conclusion is that the results of the investigation of the collection of errors and self-corrections are in line with the model for error detection as presented in chapter 2.

Part II

Experiments concerning the self-correction behaviour of good and poor readers

Chapter 6 The influence of textual coherence on the number of self-corrections

In the preceding chapters it was found that good and poor readers differ in their use of syntactic and/or semantic context information for the detection of reading errors. However, this finding was difficult to evaluate. The errors often affected both the syntactic and the semantic structure of the sentence in which they occurred. In such cases it is not clear whether the two types of information play an independent role in the detection of errors. Experiments in which the information provided by these two types of context information is manipulated independently may shed some light on their role in the detection of reading errors.

6.1 Experiment II: semantically incoherent texts

In order to isolate the role of the semantic context in the monitoring process, an experiment was carried out in which the information concerning the meaning of the sentences was manipulated. Two types of texts were presented. One type consisted of normal texts. In the other type the nouns were exchanged. In the latter case it was nearly impossible for a reader to construct a coherent meaning of the sentences, let alone of the complete text. Only nouns were exchanged so that no syntactic incoherence resulted from the operation which causes the semantic incoherence.

The difference between the two types of text is supposed to affect both the number of errors and the number of self-corrections. In the incoherent text, very little information can be drawn from the semantic context. This lack of information is supposed to lead to an increase in the level of difficulty of the text: more errors will be produced. For that same reason a decrease in the proportion of errors that are corrected will be the result.

According to the findings in the previous chapters the good readers are supposed to be more capable of using semantic context information than poor readers. The lack of this type of information should thus have greater consequences for these readers than for poor readers. Accordingly, an interaction between the groups of readers and the types of text is expected. The difference in the incidence of errors arising from coherent and incoherent texts should be greater for good readers, as should the difference in the incidence of self-corrections.

6.1.1 Method

Material. Two texts were used in the experiment. They were selected from reading books for children of about 8 or 9 years old. The main selection criterion was that the poor readers could understand the text. This was tested in a pilot experiment in which children were asked to retell the stories that were presented in the texts. The second version of every text was constructed by exchanging the nouns within the text. In exchanging the nouns, attention was paid to their gender: the exchanged nouns had to have the same gender. Thus, the only difference between the two versions consisted of the order in which the nouns appeared: the actual words and the syntactic structures were identical. Two experimental sets of texts were constructed. A set consisted of a coherent version of one text followed by an incoherent version of the other text.

Subjects. There were two groups of 16 children involved in the experiment. They were selected from an ordinary school (good readers) and from a LOM school (poor readers). The good readers' mean age was 10 years and 9 months (s.d. 13 months) while that of the poor readers was 11 years and 1 month (s.d. 5 months). The readers were selected by their teachers according to the criteria given in chapter 1. The good readers' performance on the reading test of Dommerholt (1970) was almost twice as good as that of the poor readers.

Procedure. The subjects were instructed to read the texts aloud. They were asked to read carefully, i.e. to prevent errors as much as possible by reading not too fast, and to correct errors whenever necessary. The children were encouraged to understand the meaning of the text as much as possible. Therefore, they were told that they had to answer questions after having read the texts. The reading of the first text – which was always a coherent version – was followed immediately by the questions. The first question was to retell the story. When the questions were answered, the instructions were repeated briefly before proceeding to the second text. Reading this text was followed by only one question, viz. whether there was something wrong with the text. This should indicate whether the children had noticed the incoherence. The reading of both texts was tape-recorded. The experimental session ended with a small reading test (Dommerholt, 1970). A complete session lasted about 20 minutes. The two experimental sets of material were presented alternately.

6.1.2 Results

Although there were differences between the good and poor readers in recalling the coherent text versions (differences mainly concerning the number of details and errors in the chronological order of events), there was no indication in the recall protocols that the texts were too difficult for either of the groups of readers. The good and poor readers reacted differently when asked if they had discovered something peculiar when reading the incoherent versions. On the whole, the good readers reported that the text was a mess. On the other hand, the poor readers answered that they liked the story. When asked what the text was about they started to tell a plot based on a number of content words in the text. When the experimenter stopped this recall and told them that the text was incoherent, the poor readers usually confessed with relief that the text was difficult to understand.

The data are presented in Table 6.1. An analysis of variance was carried out with the subjects as random factor. There was one within-subjects factor, the type of text (levels: semantically coherent, and semantically incoherent), and one between factor, the group of readers (levels: good and poor). There was no significant difference in the number of errors between the two types of text. The difference between the good and the poor readers was of course significant ($F(1,30) = 52.70$, $p < .01$).

Although no difference in the number of errors was found between the two types of texts it is difficult to believe that reading a coherent text is as difficult as reading an incoherent text. For instance, the mean time required for reading the coherent versions was shorter for both the good and the poor readers than the time needed to read the incoherent versions. Besides the observation of errors there is another phenomenon which points in the direction of problems in language processing. Stuttering (the first realization being only a part of the complete target word) or repetition of words may be interpreted as a sign of trouble. In studies on speech errors it is assumed that at least a number of such repetitions have to do with covert self-corrections: the error is corrected before it is actually uttered, and – prior to this correction – the speaker restarts at some point before the error in order to gain time. Both the good and the poor readers showed more repetition phenomena in the incoherent versions than in the coherent versions (see Table 6.1), and this effect (an analysis with the same factors as above) was significant ($F(1,30) = 22.51$, $p < .01$). There was neither a difference between the groups of readers, nor an interaction effect.

readers	normal text coherent text	syntactic prose incoherent text	total
	mean number of errors		
good readers	6.7	7.7	7.1
poor readers	22.1	23.6	22.9
	14.4	15.7	15.0
	mean number of repetitions		
good readers	2.7	6.6	4.7
poor readers	5.1	7.9	6.5
	3.9	7.3	5.6
	mean proportions of self-corrections		
good readers	41.5	62.1	51.8
poor readers	31.1	29.9	30.5
	36.3	46.0	41.1

Table 6.1 Errors, repetitions and self-corrections when reading normal texts and syntactic prose. (experiment II)

An analysis of variance was carried out on the proportion of self-corrections (Table 6.1). The analysis with the subjects as random factor had as within-subjects factor the type of text (levels: semantically coherent, and semantically incoherent), and as between factor the group of readers (levels: good and poor). The difference was significant both between the good and the poor readers ($F(1,30) = 10.66$, $p < .01$) and between the coherent and incoherent texts ($F(1,30) = 8.16$, $p < .01$). The interaction effect was also significant ($F(1,30) = 10.29$, $p < .01$).

6.1.3 Discussion

The results contradict the hypotheses. The number of errors does not increase with the lack of semantic information in the incoherent versions. The proportion of self-corrections does not decrease as a consequence of the incoherence in meaning. Conversely, the good readers produced most self-corrections in the incoherent text version. How can these findings be accounted for?

The results can be interpreted in two ways: either (i) the meaning of the context does not play a very important role in decoding words or (ii) the context does play an important role but the lack of context information is compensated for by a more intensive use of the other sources of information available for decoding. The number of false starts and repetitions in reading the words supports the second explanation. When reading the incoherent version, where in a great number of cases the meaning of a decoded word is not compatible with the preceding context, both the good and poor readers show higher repetition incidences than when reading the coherent versions. This points to the conclusion that although the incoherence of a text leads to observable trouble, it is clear that these readers were not heavily dependent on semantic context information to decode words properly.

Good readers made more corrections in the incoherent texts than in the coherent texts. An explanation is that the lack of coherence is not a lack of information, but rather a constant source of information. If it is difficult for a reader to make sense of the text, this functions as a constant alarm to him. The hypothesis that a smaller part of the errors would be corrected was based on the idea that there is no semantic context information to be used for detection. However, the results suggest that since, in the incoherent version, many of the realized words have the same semantic relationship (i.e. none at all) with the rest of the sentence, they are checked as being suspect. Moreover, a reader whose reading is affected by a nonsensical context will intensify the checking of other information rather than the semantic context information. This will lead to more self-corrections.

Whatever explanation may be true, a clear conclusion from the experiment is that the meaning of the context plays a role in the correction of errors, independently of the syntactic context information.

The contextual information does not seem to have a similar influence on the poor readers' correction behaviour. On the other hand, the fact that the number of repetitions by poor readers increases to the same degree as for the good readers when reading an incoherent text supports the idea that poor readers use the contextual information in some stages of their reading and in the same fashion as good readers do. In other words, reading a word which does not fit the preceding context leads to decoding problems for a poor reader (as well as a good reader), but not to an increased chance of correction (as was the case for good readers). One of the possible explanations – in which it is assumed that poor readers use context in the same way as good readers do – is presented in the following paragraph. After that, an explanation will be given in which it is assumed that there is a difference between the good and poor readers' use of the context for error detection.

Good readers read faster than poor readers. In a number of cases they may have read a word aloud before all the information is available. When the good readers read the incoherent version, alarm bells ring because things are not going very well, and consequently many words are reconsidered, using as much information as possible, leading to a number of corrections. The poor readers, on the other hand, have probably already used as much information as possible. In this case, reading an incoherent version cannot lead to a better use of whatever information there is when reconsidering the words pronounced. Good and poor readers would then only differ from the moment that the semantic context information becomes available. This difference is due to decoding speed and not to a difference in the mechanisms which use the context information for error detection.

Another explanation is that poor readers do not use context information in their error detection mechanisms. In this case, poor readers have no reason to react to the phenomenon that, when reading the incoherent versions, many words are read which do not fit the preceding context.

The conclusion may be that the good and poor readers differ in self-correction behaviour as far as the role of semantic context information is concerned. But it is not clear whether this difference occurs in the error detection mechanisms or the processes involved in decoding. Two further questions are of interest: What causes this difference, and second, can it also be found in the use of the syntactic context?

6.2 Experiment III: semantically and syntactically incoherent texts

In experiment (II), the role of semantic structures in the detection of reading errors was tested independently of the role of syntactic structures. A next step is to investigate the role of the syntactic context by varying the coherence of the syntactic structures in various texts while keeping the semantic coherence constant. However, every change in the syntactic structure of a sentence affects the meaning of that sentence. If the syntactic structure of a sentence is largely incoherent, the semantic structure will also be incoherent. It is impossible to compose a text which is syntactically completely incoherent and yet semantically coherent. In investigating the role of the syntactic context, a drop in syntactic coherence inevitably results in a drop in semantic coherence.

In this experiment the reading of a text that is both syntactically and semantically coherent is compared to the reading of a text that is both syntactically and semantically completely incoherent. The incoherence is achieved by the random distribution of all the words in the text.

The number of errors and corrections should be nearly the same when reading the coherent text versions in experiment (II) and (III). Differences between the incoherent versions of the two experiments can be ascribed to the lack of syntactic information in experiment (III).

What may be expected with respect to the number of errors when reading a text which is, linguistically speaking, virtually unstructured? In experiment (III) there is less information available for decoding the words than in the semantically incoherent text. If the text is both semantically and syntactically incoherent, it is likely that more errors will be produced than in the completely coherent version.

The number of self-corrections will be greater in the completely incoherent text than in the coherent text. The evidence of confusion will be manifestly greater in the incoherent type of text of the present experiment than in experiment (II).

As far as the difference between good and poor readers is concerned, it is expected that the increase in the number of errors will be the same for both good and poor readers in the incoherent version as compared to the coherent version (the repetitions and false starts in the previous experiment indicated that both groups of readers met the same decoding trouble in reading incoherent texts). On the other hand, it is expected on the basis of experiment (II) that the increase in the number of corrections in the incoherent version will be greater for good readers than for poor readers.

6.2.1 Method

Material. The two texts used in experiment (III) were the same as those of experiment (II). For each text, a second version was constructed in which all the words were rearranged randomly. The punctuation marks were retained, as was the number of words per line.

Subjects. The 14 good and 14 poor readers were selected according to the same criteria used in experiment (II). The mean age of the good readers was 10 years and 9 months (s.d. 8 months). The mean age of the poor readers was 10 years and 8 months (s.d. 10 months). The groups performed very differently on the reading test (Dommerholt, 1970). None of the subjects had participated in experiment (II).

Procedure. The procedure was the same as in experiment (II): after short instructions the coherent text was read and some questions about this text were answered; then, a short instruction was given, followed by the reading of the incoherent text. Each session was followed up by the reading test mentioned above to measure technical reading skills. Every session was recorded on tape for protocolizing.

6.2.2 Results

Reading the incoherent texts sometimes annoyed the children. However, all the subjects carried on till the end of the text. Their answers to the questions about the coherent texts were similar to those given in experiment (II). The coherent texts were understood satisfactorily by both groups of readers. Compared to experiment (II), a greater number of poor readers reported that they were unable to understand the incoherent text, and that this was caused by the text itself.

The findings of experiment (III) are summarized in Table 6.2. The analysis of variance on the error data had as within-subjects factor, the type of text (levels: normal, and syntactic prose), and as between factor, the group of readers (levels: good and poor) and as random factor the subjects. There was a main effect of the type of texts ($F(1,26) = 71.85$, $p < .01$). There was also a significant difference between the good and poor readers ($F(1,26) = 112.85$, $p < .01$). The significant interaction between these two factors ($F(1,26) = 36.51$, $p < .01$) suggests that the context manipulation has a greater effect on the reading of the poor readers than on that of the good readers.

readers	normal text	syntactic prose	total
		mean number of errors	
good readers	4.7	10.6	7.7
poor readers	24.9	46.3	35.6
	14.7	28.5	21.6
		mean number of repetitions	
good readers	2.4	5.4	3.9
poor readers	5.3	5.2	5.3
	3.8	5.3	4.6
		mean proportions of self-corrections	
good readers	48.4	33.9	41.2
poor readers	16.1	9.9	13.0
	32.3	21.9	27.1

Table 6.2 Errors, repetitions and self-corrections when reading normal texts and randomly ordered words. (experiment III)

The analysis of variance on the correction data contained the same factors as reported above. The differences between the type of texts as well as the group of readers were significant ($F(1,26) = 4.21$, $p < .05$ and $F(1,26) = 48.49$, $p < .01$, respectively). No interaction was found between these main effects.

6.2.3 Discussion

The main hypotheses about the self-correction behaviour when reading a text in which both the syntactic and semantic context are manipulated simultaneously are not supported. On the contrary, in reading texts which are completely incoherent, a significantly smaller proportion of the errors is corrected than in reading a coherent text. Moreover, no difference in the use of context for correction purposes was found between the good and poor readers. As predicted, the experimental manipulation of the texts led to a considerable increase in errors, when compared to those texts which are completely coherent or those in which only the semantic context is disturbed.

The consequences of removing all the syntactic and semantic context information are considerable. The number of errors doubles and the proportion of corrections decreases for both groups of readers. It is not clear whether this high number of errors is caused by the fact that in reading a word no use can be made of the preceding syntactic and semantic context or whether the incoherence of both types of context leads to confusion. The question whether the lack or inconsistency of the context information is responsible for the high number of errors that are found in the present experiment will be addressed in experiment (IV).

How can the results with respect to the self-correction data be accounted for? Obviously, the high number of errors leads to a small proportion of self-corrections. The detection of errors is to a great extent dependent on the correct functioning of the processes involved in the perception and/or production of language. In the error detection model, presented in chapter 2, it is assumed that errors are found by the detection mechanisms in various processes. If, due to the extreme difficulty of the text, errors are constantly detected in many processes, and if these errors cannot be repaired, it seems useful to ignore the error detection signals. The basic assumption then is that the central *process monitor* can quite deliberately respond less frequently given an increased frequency of errors.

At least, it may be concluded that the experiments (II) and (III) provide firm evidence for the fact that the functioning of the correction behaviour is affected by the coherence of the text. The results of the present experiment can provide an explanation for the difference in context use that was found between good and poor readers in the analysis of the corpus of errors and self-corrections. Poor readers meet so many problems in decoding most words that their error detection mechanisms – which may be triggered by the same information, and which may be handled in the same fashion by good and poor readers alike – have insufficient information to function properly.

Is it a general rule that the number of self-corrections decreases when a reader has to decode an overly difficult text? This question will be subject of experiment (V).

6.3 Experiment IV: word lists

In the previous experiment, rather dramatic results were obtained when subjects had to read text in which the syntactic and semantic coherence had been completely destroyed by presenting the words in a random order. The subjects seemed to be puzzled by the fact that something which looked like a text did not show any internal syntactic or semantic consistency. It seems useful, however, to investigate whether a high number of errors accompanied by a low proportion of corrections is caused by the lack of contextual information or by the inconsistency of that information (the latter leading to confusion). One manipulation which will lead to an absence of contextual information rather than a contradictory context is the presentation of a text as a *list* of words in a random order.

What predictions can be made about the error incidence and self-correction behaviour when reading a list of words? Context information is not obligatory information for the correct decoding of words – although it may affect reading speed. The lack of context information, as is the case with a random word list, will not lead to a higher number of errors than in the normal text versions. The number of self-corrections will also be the same for both versions. Accordingly, no difference between the good and poor readers will occur except for the usual differences in number of errors and corrections, which will be equal for both types of text presentation: good readers make fewer errors and more corrections than poor readers.

6.3.1 Method

Material. The texts were identical to those used in experiment (II) and (III). The incoherent versions were constructed by putting all the words of a text in a column. The order of the words was random. The punctuation marks were omitted.

Subjects. The 14 good readers (mean age 11 years and 1 month, s.d. 5 months) and the 14 poor readers (mean age 10 years and 4 months, s.d. 9 months) were selected in the same way as in the previous experiments. None of the subjects had participated in previous experiments.

Procedure. The procedure was the same as in experiment (II) and (III). Of course, no questions about the story followed the reading of the word list, which was always presented after the subjects had read the coherent text. Readers were simply asked whether the words were difficult to read.

6.3.2 Results

The data are presented in Table 6.3. The number of errors for the good readers was about the same in both conditions. The same is true for the poor readers. The number of self-corrections, too, did not differ for the two types of presentation: the normal version showed a correction incidence of 35.5% – when calculated over the complete group of readers – and the randomly ordered list version led to a correction incidence of 36.0%. The analysis with the subjects as random factor had as within-subjects factor, the type of text (levels: normal, and word list), and as between factor, the group of readers (levels: good and poor). The type of text did not lead to significant differences in the number of errors or self-corrections. There was a significant difference between the two groups of readers for reading errors ($F(1,26) = 119.19$, $p < .01$) and for proportions of self-corrections ($F(1,26) = 22.90$, $p < .01$). These were the only significant effects.

readers	normal text	word list	total
	mean number of errors		
good readers	5.1	5.0	5.0
poor readers	24.0	22.6	23.3
	14.5	13.8	14.2
	mean number of repetitions		
good readers	2.4	2.4	2.4
poor readers	5.6	5.9	5.8
	4.0	4.1	4.1
	mean proportions of self-corrections		
good readers	50.6	53.1	51.9
poor readers	20.3	18.9	19.6
	35.5	36.0	35.7

Table 6.3 Errors, repetitions and self-corrections when reading normal texts and lists of words. (experiment IV)

6.3.3 Discussion

The results support the hypothesis. The number of errors as well as the proportions of self-corrections are not very different, whether the words are presented in their context or as a word list. Reading a list of words may be considered very different from reading a text, since e.g. the intonation patterns are completely different. The main reason for carrying out this experiment was not to investigate the differences between texts and word lists, but to verify whether the results of experiment (III) were based on the inconsistency of the syntactic and semantic context information or merely on the lack of this information. The conclusion from the experiment is that the findings of experiment (III) are due to the inconsistency rather than the lack of context information. In this experiment, the readers showed that they can compensate for the absence of a context. The main conclusion of the previous experiments may be that children's reading strategies vary with the available higher-level information, a finding also reported by other investigators (e.g. Bowey, 1984), and that correction strategies, too, can be varied.

6.4 Experiment V: texts of various levels of difficulty

When comparing good readers with poor readers, one invariably finds that poor readers make more errors and correct proportionally fewer. There is a clear negative correlation between the number of errors a reader produces and the proportion of errors he corrects. For instance, the 42 readers who produced the corpus of errors and self-corrections showed a significant negative correlation between the number of errors and the proportion of self-corrections ($r(40) = -.59$, $p < .01$). The present experiment investigates the relation between errors and self-corrections for a variety of texts that increase in difficulty.

If the level of difficulty of texts increases, so does the incidence of error. The more words are read incorrectly, the less consistent the text will be to the reader. On the basis of the error and correction data of the experiment (II) and (III) it is expected that an increasing level of difficulty first leads to an increase of the number of corrections. However, at a certain level of difficulty the proportions of self-corrections decrease. This point will be different for good and poor readers.

6.4.1 Method

Material. In order to get a wide variety in levels of difficulty 5 texts were selected from ordinary reading books in the following way. One text of moderately difficulty was selected. This had to be read by every reader in the experiment. In addition to this text, 4 other texts were selected, varying as much as possible in difficulty (two texts being easier and two being more difficult than the one presented to everyone). The difficulty was established on the basis of mean word-length and mean clause-length. The text lengths were made nearly equal by stopping after the sentence in which the 245th word of the text occurred (the lengths ranged from 246 to 249).

Subjects. The children were selected following the same procedure and criteria as in the previous experiments. The mean age of the good readers (N = 15) was about 9 years and 8 months (the exact birthdays were not all known), the mean age of the poor readers (N = 15) was about 10 years. The Dommerholt reading test confirmed that the good readers were much better than the poor readers.

Procedure. To restrict the reading time of the poor readers to a reasonable amount, every reader read only 3 texts (approximately 750 words). This trio always consisted of a relatively simple text, the standard text and finally, a relatively difficult text. Thus, the standard text was read 15 times by both the good and the poor readers, one simple and one difficult text was read 8 times by both groups of readers and one simple text and difficult text was read 7 times. The order in which the texts appeared was varied systematically.

The readers were instructed to read the three texts as carefully as possible. It was emphasized that they should make few errors and correct them if possible. One third of a group of readers started with a very difficult text, one third with a moderately difficult text and one third with a relatively simple text. After they had read the three texts, a short reading test was administered (Dommerholt, 1970). The sessions were tape-recorded to make accurate observations of the errors and self-corrections possible.

6.4.2 Results

An analysis was carried out to decide whether the texts differed with respect to the number of errors they elicited and whether these differences corresponded to the differences in difficulty. To this end, the 5 texts were rank-ordered in difficulty according to word-length and clause-length and the number of errors for each text were counted. Each subject read three texts, so that two comparisons on the number of errors could be made per subject: first, whether the supposedly simple text led to fewer errors than the standard text and, second, whether the supposedly difficult text led to more errors than the standard text. For the good readers, the texts elicited a number of errors that conformed to the ordering in 80% of the cases (N = 30: 15 subjects x [3 - 1] texts). For the poor readers the texts led to an error number that conformed to their rank order in 97% (N = 30).

The good readers corrected 35.0% of their errors in those texts in which they made the fewest errors, 33.3% of their errors in the text which turned out to be intermediate difficulty, and 19.4% of the errors in the most difficult text. The corresponding numbers for the poor readers were 27.7, 17.7, and 8.6 per cent. A more detailed picture of the numbers of correction is presented in Figure 6.1. Both the good and the poor readers showed a significant negative correlation between the number of errors and the number of corrections ($r(43) = -.41$, $p < .01$ and $r(43) = -.43$, $p < .01$).

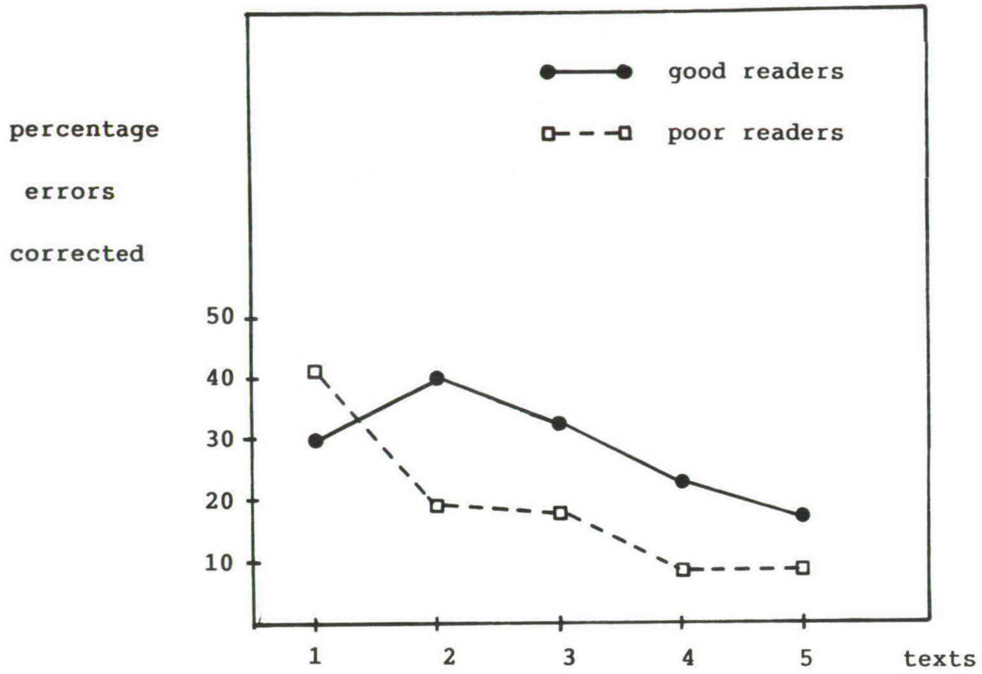

Figure 6.1 The relation between the error rate and the correction rate. (experiment V)

6.4.3 Discussion and conclusions

For both the good and the poor readers it may be claimed that there is a strong relationship between the error incidences and the correction incidences. Wixson (1979) concluded on the basis of so-called miscue analyses that the nature of the errors and the number of errors vary as a function of the structure and the contents of written material. In the present experiment it was clearly found that there is a firm relation between the difficulty of a text, the number of errors, and the number of corrections. What happens if the difficulty of the reading material is increased?

First, the number of successful self-corrections decreases if a text is more difficult, since the reader fails to correct the errors in a number of cases in spite of the fact that he detected them. A straightforward prediction that can be made on the basis of this assumption is that the number of errors detected without leading to a complete correction increases if the difficulty of the texts increases. Detected errors are – like in chapter 3 – all errors on which a second attempt can be observed. In Figure 6.2 the proportions of detected errors that are not corrected are presented for the five texts. Apart from text five there seems to be a positive correlation between the difficulty of a text and the proportion of error detections that are not corrected.

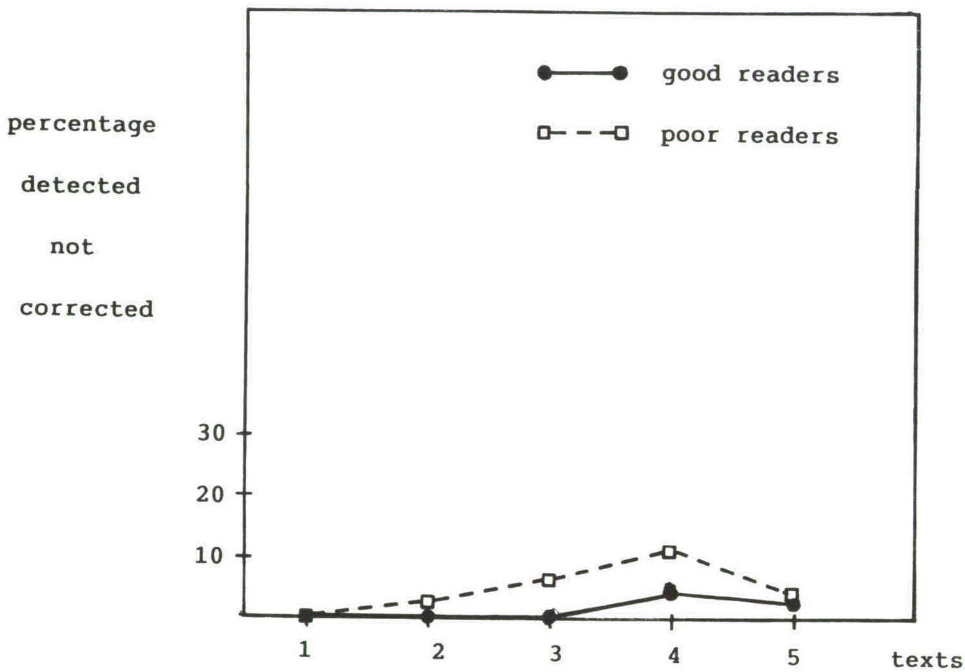

Figure 6.2 The relation between the difficulty of texts and the proportion of detected but uncorrected errors. (experiment V)

Second, the amount of information for detecting errors - viz. the semantic and syntactic context information - decreases if the texts are too difficult. The most difficult text (5) showed a decrease in the number of error detections that are not corrected (Figure 6.2) as well as a decrease in the number of successful corrections (Figure 6.1).

At least in experiment (II), the good readers showed an increase in the number of their corrections when the difficulty of a very easy text was slightly increased. Figure 6.1 shows the optimum level of difficulty for the good readers (text 2). For the poor readers this optimum may be found if the texts are even more simple than those used in the current experiment.

The most striking conclusion that can be drawn from these experiments is that the correction behaviour of good and poor readers is very similar. Differences in the correction behaviour of the two groups can largely be explained in terms of the relative difference in difficulty when reading a given text. If the text is very difficult for both groups of readers the difference in correction incidences decreases considerably (see Figure 6.1).

Given the importance of the optimal correction behaviour in practising to read it seems advisable to use reading material on an appropriate level of difficulty. The reading material should by no means be too difficult, but the other side of the coin is that a text has to be difficult enough. The conclusion may be that there is an optimum level of difficulty for each reader at which he or she should practise. At this optimum, reading the texts produces a moderate number of errors and a maximum number of self-corrections.

The main conclusion of this chapter is twofold. First, syntactic and semantic context information seems to form independent sources for error detection. Second, the number of errors which are detected and corrected is closely related to the difficulty of the texts: if a text is too easy or too difficult, correction will be performed at a relatively low level.

Chapter 7 Self-corrections on the basis of the syntactic and semantic context

The previous experiments showed that the proportion of corrected errors depends on the number of errors made and can be influenced by the coherence of the syntactic and semantic context. These factors may explain the differences in the use of context that can be found between good and poor readers in error detection. The analysis which showed the difference between good and poor readers (chapter 3 and 4) was based on the reading of a text in which the poor readers differed considerably from the good readers in the number of errors and hence in the syntactic and semantic context information which was at their disposal. A way to study the question whether there are differences in the use of context for the detection of errors between good and poor readers, is to provide the poor readers with contextual information by minimizing the number of errors of the reading.

Poor readers have good contextual information available, when they have to detect errors in the reading of someone else. It is then possible to manipulate the incidence of errors. Moreover, it is possible to determine the type of errors that have to be detected. It is known when the information for error detection becomes available, and this provides a starting point for measuring reaction times in a particular task. Then, it is not only possible to study what information is used to detect a certain error, but also the time taken in the course of detection.

When the auditory material which has to be monitored is not produced by the reader himself, this will lighten the reader's task and the pressure on the mental system will be less than when reading aloud. In particular, poor readers will have the opportunity to concentrate more on the monitoring task and show their potential skills in this aspect. The measurements for the error detection behaviour of the poor readers will in the present task be influenced less by the reading problems of those children and thus probably shed more light on the (causal) relationship between error detection problems and reading problems.

Since in the previous analyses of spontaneously occurring correction behaviour, differences were found between good and poor readers in the use that they make of the context in their self-correction behaviour, context was the main independent variable in the present experiments. It was decided that a start would be made with an investigation of the role of the semantic context.

7.1 Experiment VI: the semantic context

In this experiment the texts were visually presented on a screen and simultaneously presented auditorially by means of a tape recorder. The subjects were asked to read the sentences and check whether there was an error in the auditorial stimuli. All the errors in the experiment were detectable on the basis of a difference in letters and sounds and a difference in the word meaning between target and error. Half of the errors in the experiment could also be detected on the basis of a conflict between the error and the preceding semantic context (examples of the errors are given in the section *material*).

Hypotheses can be formulated with respect to the number of errors that are detected and the time needed to detect the errors. Since analyses in chapter 3 showed that semantic context information is used for error detection, it was expected that both the good readers and the poor readers would show a higher proportion of detected errors when the errors did not fit the preceding context. On the basis of the findings in chapter 4 – if the context provides a clue that there is an error the moment of interruption is less delayed – it was expected that the errors which could be detected on the basis of the context would be detected faster than those which could not.

According to the findings of chapter 3 and 4, good readers will differ from poor readers in their overall proportion of detected errors (irrespective of the types of information available). Good readers will increase their proportion of detected errors as well as the speed of the error detection on the basis of the availability of semantic context information more than poor readers do.

7.1.1 Method

Material. In example (7.1) a "reading error" is presented which had to be detected during the experiment. The sentence in (7.1)-T was presented visually and sentence (7.1)-R was presented auditorially. The error which had to be detected fitted the preceding context. The difference between target and error consisted always of one letter/sound; unlike the phonemic difference between English *pipes* and *mice* the difference between the Dutch words 'buizen' and 'muizen' is restricted to only one phoneme.

The same error (reading *mice* for *pipes*) was also presented in sentences (7.2). If the error is to be detected in the context of *There are a lot of birds living in those ...*, then the error can be detected not only on the basis of phonemic and semantic differences between target and error, but also on the basis of the preceding context. The semantic incoherence arises only in the auditorially presented sentence ([7.2] R; not in [7.2] T).

(7.1) Semantically acceptable error
- T Door de kelder liepen veel dikke *buizen*.
- R Door de kelder liepen veel dikke *muizen*.
- ET In the cellar there were a lot of large *pipes*.
- ER In the cellar there were a lot of large *mice*.

(7.2) Semantically incorrect error
- T Er wonen veel vogels in die *buizen*.
- R Er wonen veel vogels in die *muizen*.
- ET There are a lot of birds living in those *pipes*.
- ER There are a lot of birds living in those *mice*.

In order to ensure that the sentence parts that preceded the target word appeared in both context conditions, the sentence parts used in (7.1) and (7.2) appeared also with another target word and error such that the conditions were turned around: examples 7.3 and 7.4. The error in (7.3) (reading 'huizen' instead of 'buizen') is detectable on the basis of the preceding context; the same error in the sentences of (7.4), however, is not detectable on the basis of the preceding context.

(7.3) Semantically acceptable error
T Door de kelder liepen veel dikke *buizen*.
R Door de kelder liepen veel dikke *huizen*.
ET In the cellar there were a lot of large *pipes*.
ER In the cellar there were a lot of large *houses*.

(7.4) Semantically incorrect error
T Er wonen veel vogels in die *buizen*.
R Er wonen veel vogels in die *huizen*.
ET There are a lot of birds living in those *pipes*.
ER There are a lot of birds living in those *houses*.

To make sure that there was context available at the moment that the error had to be detected, the errors occurred at the end of each sentence. Research by, amongst others, Aaronson and Scarborough (1977) and Just and Carpenter (1980) provides evidence that contextual integration processes take place at important phrase boundaries. Presentation of the error at the end of the sentence also guarantees that no additional information which can be used for error detection is provided after the occurrence of the error. The status of the detection times would be unclear if any information became available after the presentation of the target words.

Ten experimental items were constructed which consisted of 4 pairs of sentences like those presented in examples (7.1) to (7.4). An experimental list consisted of 10 errors which fitted the preceding context (like those in [7.1]) and 10 errors which did not fit the preceding context (like in [7.2]). There were four experimental lists. Through such an approach, it was possible to vary systematically the order in which the errors with respect to the context occurred (i.e. if in one list an error was presented first in the context of [7.2, incoherent] and after that in the context of [7.1, coherent], then in another list the error was presented first in the context of [7.1] and then in the context of [7.2]). Each sentence occurred in every condition (cf. [7.1] and [7.2] versus [7.3] and [7.4]).

The four experimental lists were supplemented by a set of distractors. To avoid any effects of the position of the experimental errors in the sentences (always the last position), 15 sentences were presented in which the error occurred in a position other than sentence-finally. There were also 15 filler items in which no error occurred at all. This was done in order to prevent subjects from adopting the strategy "when reaching the last word of a sentence without encountering an error, react", since there must be an error. At the beginning of each list there were 10 practice sentences, 5 of which contained an error.

Subjects. Fourteen good readers (mean age: 10 years, 9 months; s.d. 8 months) and fourteen poor readers (mean age: 11 years, 1 month; s.d. 9 months) participated in the experiment. They did not participate in any of the previous experiments reported in this study. The criteria and procedure to select the subjects were the same as in previous experiments.

Procedure. The subjects were instructed to look at a monitor on which the sentences were presented. They had to consider the auditorially presented sentence as being the "read aloud" version of the visually presented sentence. They were asked to press a button as soon as they detected an error in the "read aloud" sentence. The subjects were to press with their dominant hand.

Each word was read as it appeared on the screen. At the end of each sentence the screen was cleared. The subjects knew where the words were going to appear because lines appeared on the screen at places where the words were to be presented. The timing as well as the coordination between the screen and the tape recorder was controlled by a micro computer (Apple II+). The words were presented at a rate of one word per 1.3 seconds. Whenever a word was "read" wrongly, it was recorded how much time elapsed between the beginning of the display of the word on the screen (simultaneous with the start of the word on tape) and the push of a button. If there was no reaction after 3 seconds (the time interval between the sentences) the error was recorded as not being appropriately detected . If a subject pressed the button, despite the fact that there was no reading error, this was registered by the experimenter.

7.1.2 Results

None of the children had any problems in carrying out the task. Most children pushed no more than once while there was no error. There was only one child who erroneously reacted 5 times. The errors were nearly always detected by both the good and the poor readers. There was only one child who failed to detect as many as 3 errors. It may be clear that the number of times a target word was missed turned out to be very small. The good readers failed to detect 10 target errors (3.6%) and the poor readers 12 target errors (4.3%). Of these failures, 7 and 4 cases respectively were mistakes on errors which fitted the context.

Reactions that took more than 3 seconds were not recorded as valid reactions and replaced by estimated values based on the subject mean, the item mean and the grand mean. Moreover, a reaction time was replaced if it was both not within the range of a subjects' mean plus or minus twice his standard deviation, and not within the range of the mean of the item plus or minus twice the standard deviation of that item. For each reader the mean time was calculated that was needed to detect the errors which fitted the context and those which did not. The means for the subjects are presented in Table 7.1.

Two analyses of variance were carried out on the reaction times: one taking the subjects as the random factor and one taking the items as the random factor. The analysis with the subjects as the random factor had as within factor the context of the error (levels: semantically acceptable, and semantically incorrect), and as between factor the group of readers (levels: good and poor). The analysis with the items as the random factor had as within factors the group of readers (levels: good and poor), and the context of the error (levels: semantically acceptable, and semantically incorrect).

The mean latencies in error detection for good readers were smaller than for poor readers ($min\ F'(1,22) = 6.39$ $p < 0.05$, one-tailed). Errors that did not fit the context were detected significantly faster than those that did ($min\ F'(1,22) = 3.67$ $p < 0.05$, one-tailed). This effect was not different for good and poor readers: the interaction was not significant.

readers	the error fits the context	the error does not fit the context
good readers	815	793
poor readers	1104	1036

Table 7.1 Mean detection times [ms] for errors that fit the preceding semantic context and for errors that do not. (Experiment VI)

7.1.3 Discussion

The results of this experiment confirm that the semantic context plays a role in the detection of errors. Whenever there is semantic information for error detection, this leads to short detection times. However, it is not clear whether the magnitude of differences in time between errors detectable by the semantic context and errors not detectable by the context is correct. In the experiment words are presented both visually and auditorially. The auditorially presented words varied considerably in the way they fitted the preceding context. On the basis of word-recognition experiments involving targets in normal contexts it has been concluded that the context plays an important role in the fast identification of the targets. Shadowing and word monitoring tasks of auditory stimuli (e.g. Marslen-Wilson, 1985; Marslen-Wilson & Tyler, 1980) have shown that word identification is very fast, if the words are presented in context. As Grosjean (1980) demonstrated, words may be identified within 200 ms. when presented in a sentential context, as opposed to over 300 ms. when presented in isolation. By means of Grosjean's (1980) gating task it is possible to obtain a very direct measure of the lexical selection point of a word, i.e. the point where the acoustic-phonemic input suffices to decide what the word must be. Research on these selection points has shown that spoken words can be identified before the selection point is reached if they are presented in an appropriate context (Marslen-Wilson and Tyler, 1980). Marslen-Wilson and Tyler (1980) presented words in three monitoring tasks in three types of context: normal prose, syntactic prose, and random word order. The subjects had to look for identical words, words that rhymed with a previously given target or words that were identical in category. They found that all the tasks were performed fastest in normal prose. It seems reasonable to expect that the errors, when presented in various contexts, are recognized at various speeds (cf. Cole & Perfetti, 1980). In a subsequent experiment (VIII) the effect of differences in context on the recognition of the auditorially presented errors will be measured.

In the experiment only one source of information for error detection was investigated, the semantic context information. However, the current findings seem to support the idea that error detection is based on multiple sources of linguistic information: if one source of information is not available (semantic context) the errors are still discovered.

Good and poor readers do not differ in the use that they make of the semantic context for the detection of errors. This conclusion contradicts the findings of the analyses of the collection of reading errors and self-corrections in part I: good readers seemed to make more use of context information for error detection than poor readers. One way to explain this is that the poor readers have a good context available in the current experiment, whereas they did not when reading the text in part I. Another way to explain the contradiction would be to take into consideration the syntactic context. It is possible that errors which do not fit the syntactic context are detected in a different way from semantically inappropriate errors. It may be recalled that the presence of syntactic incoherence was closely related to the presence of semantic incoherence in errors that occur naturally. Consequently, the findings of part I about the use of the semantic context in the detection of spontaneously occurring errors could be due to syntactic context effects, whereas the effect in the experiment here presented was solely due to the semantic context. If the findings of part I were indeed syntactic, one expects that the syntactic effects will differentiate clearly between good and poor readers in an experiment analogous to this experiment in which the syntactic context is manipulated. This will be done in a subsequent experiment (VIII).

The good readers detected the errors faster than the poor readers. It is unclear whether this difference in latencies can be explained in terms of differences in processing of linguistic material or in terms of non-linguistic behaviour (such as the differences in motor control when pushing a button). The next experiment (VII) investigates whether the differences in their reaction times have to do with a difference in the processing of visual nonverbal material, or auditory nonverbal material or both.

7.2 Experiment VII: measuring the poor readers' reaction times

Two question had to be answered by the experiment: (i) what is the difference in reaction times between good and poor readers when reacting to nonverbal stimuli, and (ii) is it possible to ask good and poor readers what their 'dominant hand' is? In the previous experiment the readers had been asked what their dominant hand was, and they had been requested to use that hand to mark the detection of an error. It was not completely clear whether this simple procedure of asking the readers would lead to the desired result in all cases. Probably, there are children who may be considered ambidextrous, or who, for whatever reason, contrary to the truth reported to be right handed.

7.2.1 Method

Material. There were 20 trials in which a reaction had to be given on the basis of a nonverbal *auditory* stimulus and 20 trials in which the stimulus material was of a nonverbal, *visual* nature. The auditory items consisted of ten beeps of a high frequency and ten beeps of a low frequency. No information concerning the frequency, intensity, etc., of the beeps is available, but a small pilot experiment (8 adults) showed that it was easy to discriminate between the two types of beep. The visual items consisted of ten plus signs and ten minus signs. The vertical bar of the plus sign was 6 cms high and 2 cms wide, and the horizontal bar 2 cms high and 5 cms wide. The minus sign was constructed by leaving out the vertical bar of the plus sign. Six trials were given to practise the task.

Subjects. The subjects were selected using the same selection criteria as in the previous experiment. The 14 good readers (mean age 11 years and 1 month, s.d. 3 months) and the 14 poor readers (mean age 11 years and 6 months, s.d. 7 months) did not participate in any of the other experiments reported in this study.

Procedure. The present experiment was carried out after another experiment not reported in this study. In the present experiment one half of a group of subjects received the auditory material first while the other half received the visual material first. One half of the subjects was instructed to press the button with the right hand on the occasion of a high tone beep and a plus sign while the other half was asked to do so with their left hand. They had to react to the complementary signal/sign with the other hand. In order to answer the second experimental question the subjects were asked what their dominant hand was.

The apparatus and the buttons which had to be pressed were the same as those in the previous experiment. Before an auditory stimulus was presented a short warning signal (another beep of the micro computer) was presented, and visual stimuli were preceded by a small asterisk. The delay between warning signal and target was 500 ms. Between the trials there was a delay of 2 seconds. The reaction times were measured between the beginning of the sound signal on the tape or the start of the presentation of the sign on the screen and the button press. The two parts of the experiment (auditory and visual) were separated by a short pause. The experiment took about 5 minutes.

7.2.2 Results

Neither the good nor the poor readers had any problems in carrying out the task. In Table 7.2 the reaction times given were the result of the subjects pressing the button with what they claimed was their dominant hand. Clearly, there were no significant differences between the groups of readers ($F(3,78) < 1$).

readers	the way of presenting the sign				total
	auditive		visual		
	high tone	low tone	plus	minus	
good readers	469	479	480	491	480
poor readers	479	464	483	479	476

Table 7.2 Mean reaction times [ms] for non verbal auditive and visual signs. Reactions with preferred hand (Experiment VII)

The hand dominance as reported by the children was in all cases but one in agreement with the reaction time data. When a child reported that a certain hand was dominant the mean reaction time produced by pressing the button with that hand was shorter than the mean reaction time produced with the other hand. The child whose reaction times were not in line with the reported dominance showed a very small difference between the mean reaction times of both hands.

7.2.3 Discussion

The results clearly show that measuring the reaction times on a nonverbal task lead to equal results for the good and poor readers. Consequently, differences between good and poor readers such as those that were found in experiment (VI) cannot be explained in terms of good readers being better 'button pressers'. It must be noted that even on some verbal tasks equal reaction times are measured between good and poor readers (e.g. Perfetti, Finger & Hogaboam, 1978).

Asking the children to react with their dominant hand is appropriate.

7.3 Experiment VIII: semantic and syntactic context

Experiment (VI) showed that whenever the semantic context suggests that an error occurred, this will lead to a faster detection of that error. Disturbing the context will not only influence the speed with which errors are detected but also the speed with which the errors will be recognized. These effects may be assumed to be in the opposite direction: if the context is incoherent, the error detection will be fast but the word recognition will be slow. Since the detection mechanisms are supposed to be part of the language processing system, the effects of an error on that system should also be accounted for.

Since the error detection mechanisms are supposed to work on the outcome of the various processes involved in the production and perception of language, it is difficult or even impossible to investigate the functioning of these mechanisms and that of the central *process monitor* independently of the functioning of these various language processes. However, it is possible to investigate the consequences of the presentation of a given type of error for the language processes quite independently of their consequences for the error detection mechanism. To do so, subjects are asked to react to target words in auditorially presented sentences. In these sentences the context information can be manipulated in the same way as in the error detection experiment.

If the extra time needed to recognize errors in a certain context is known, the net time for error detection can be estimated by subtracting the extra processing time from the total detection time.

In experiment (VI), poor readers were equal to good readers in using context to detect errors. The present experiment examines whether the role of syntactic context information in error detection is equal for good and poor readers.

Sentences were presented in the same way as in experiment (VI). All the errors were detectable on the basis of at least two differences between the target word and the produced word. First, one letter was not realized correctly, and second, the meaning of the target word differed completely from that of the produced word on the tape recorder. On top of that some errors were detectable on the basis of the preceding semantic context, some did not fit the preceding syntactic context and some fitted neither the semantic nor the syntactic context (examples are presented in the section *material*).

Two tasks were employed, one to measure the detection time, and one to measure the word recognition time. In the error detection task the subjects had to inspect the simultaneously presented auditory and visual sentence and to press a button as soon as an error occurred. In the word monitoring task, the subjects had to listen to the auditorially presented sentences and to react whenever a target word – given before the beginning of the sentence – was detected. The *real* detection time for errors of a given type is considered to be the time measured in the error detection task for that type of error minus the difference between the word recognition times for the errors that fitted the context and the word recognition times for the errors of that given type.

The predictions are as follows. (i) A word which does not fit the preceding syntactic and/or semantic context will be *recognized* slower than a word which does. (ii) An error which does not fit the preceding syntactic and/or semantic context will be *detected* faster – at least in terms of the *real* detection time – than a word which does. (iii) If an error is detectable on the basis of a combination of semantic and syntactic context information the detection time will be shorter than that required for either an error which fits the preceding context, or an error which is detectable on the basis of the preceding semantic context only, or an error which is detectable on the basis of the preceding syntactic context only. This prediction is based on the idea that the detection is done by mechanisms that produce their outcomes simultaneously: the more processes may discover a problem, the faster this will lead to an action of the central *process monitor*. It is based on the findings of experiment (VI) in which a combination of semantic context with other sources of information led to faster reaction times. (iv) The opposite is supposed to be true for the *recognition* of words which do not fit the preceding semantic as well as syntactic context: their recognition will be slowest, since two information sources for recognition cannot work properly.

7.3.1 Method

Material. There were four types of errors. In example (7.5) the error is detectable on the basis of the discrepancy between 'p' and 'b' as well as on the basis of the difference in meaning between 'paard' (*horse*) and 'baard' (*beard*). The other three types of error are at least detectable on the same grounds. The second type of error (example 7.6) is detectable on the basis of the syntactic structure. This is due to the difference in gender of the article 'het' and the Dutch noun 'baard'. The third type of error (example 7.7) is equal to one already presented in experiment (VI): it is detectable on the basis of the incoherent semantic context. The fourth type of error (example 7.8) can be detected both by the syntactic and the semantic context.

(7.5) Semantically and syntactically acceptable error
T De kabouter was erg trots op zijn *paard.*
R De kabouter was erg trots op zijn *baard.*
ET The goblin was very proud of his *horse.*
ER The goblin was very proud of his *beard.*

(7.6) Semantically acceptable and syntactically incorrect error
T De kabouter was erg trots op het *paard.*
R De kabouter was erg trots op het *baard.*
ET The goblin was very proud of the *horse.*

ER The goblin was very proud of the *beard.*

(7.7) Semantically incorrect and syntactically acceptable error
T De ruiter sprong op zijn *paard.*
R De ruiter sprong op zijn *baard.*
ET The horseman jumped on his *horse.*
ER The horseman jumped on his *beard.*

(7.8) Semantically and syntactically incorrect error
T De ruiter sprong op het *paard.*
R De ruiter sprong op het *baard.*
ET The horseman jumped on the *horse.*
ER The horseman jumped on the *beard.*

There were 8 "errors" such as 'paard'/'baard' for which 4 contexts were constructed like those in (7.4) to (7.8). All the target errors appeared at the end of the sentences in which they were presented. Four experimental lists were constructed in which eight errors of each type were presented. Every target word appeared in each list. The context in which it appeared was different for each list. Apart from the sentences with target errors there were also 15 sentences in which no error occurred at all and 15 sentences in which the error did not occur in the last position in the sentence. Each list was preceded by the same set of 8 practice sentences in which 4 errors occurred.

Subjects. Twenty good readers and twenty poor readers took part in the experiment. The selection procedure and criteria were the same as in previous experiments. The mean age of the good readers was 10 years and 9 months (s.d. 9 months), the mean age of the poor readers 10 years and 7 months (s.d. 7 months). None of the children that were selected had participated in any of the previous experiments.

Procedure. Half of each group of readers did the word monitoring task first and the error detection task afterwards. The rest of the subjects received the tasks in the reverse order. The instructions for the error detection task were the same as in experiment (VI). Before the word monitoring task the subjects were told that they would hear one word before every sentence. They had to listen carefully and whenever that word occurred in the following sentence they had to press the button immediately.

The equipment for the stimulus presentation and data recording was the same as in experiment (VI). The words were presented at a rate of one word per 1.3 seconds. In the word monitoring task the the same tapes were used as for the detection task. A complete session, ending with a short reading test, lasted about 35 minutes.

7.3.2 Results

Neither group of readers had any problems in carrying out the error detection task or the word monitoring task. The good readers failed to detect the error in 14 cases (4.4%). In 18 cases they failed to monitor a word correctly (5.6%). For poor readers these numbers were 13 (4.1%) and 26 (8.1%), respectively for the two tasks. In both tasks the number of times a reaction was given without an appropriate inducement was at maximum 1 per subject. The reaction times that did not meet the criteria as used in experiment (VI) were replaced by estimates.

The mean latencies required to detect the various types of errors are presented in Table 7.3. In the analysis of variance of the error detection times in which the subjects were taken as the random factor, the two within subject factors were the semantic context (levels: acceptable and incorrect), and syntactic context (levels: acceptable and incorrect), and the between factor was the group of readers (levels: good and poor). The analysis with the items as the random factor had three within factors, the group of readers (levels: good and poor), the semantic context (levels: acceptable and incorrect), and the syntactic context (levels: acceptable and incorrect).

The good readers were faster than the poor readers ($min\ F'(1{,}42) = 5.33$, $p > 0.05$, one-tailed). The availability of semantic context information led to a decrease in reaction times (41 ms.) ($min\ F'(1{,}99) = 6.41$, $p > 0.05$, one-tailed). Thus, the results of the present experiment replicated the findings in Experiment (VI). The availability of syntactic context information led to an increase in reaction times (39 ms.), which is only significant in the analysis in which the subjects are taken as the random factor ($Fs(1{,}38) = 8.50$, $p < 0.01$, one-tailed). None of the possible interactions turned out to be significant. This means, inter alia, that good and poor readers do not differ in the use of the context.

readers	the context for the error is			
	semantically acceptable		semantically incorrect	
	syntactically		syntactically	
	acceptable	incorrect	acceptable	incorrect
good readers	585	608	540	587
poor readers	781	811	719	774

Table 7.3 Mean detection times [ms] for errors presented in various contexts. (Experiment VIII)

readers	the context for the target word is			
	semantically acceptable		semantically incorrect	
	syntactically		syntactically	
	acceptable	incorrect	acceptable	incorrect
good readers	548	598	586	616
poor readers	819	886	915	930

Table 7.4 Mean recognition times [ms] for words presented in various contexts. (Experiment VIII)

The mean reaction times in the word monitoring are presented in Table 7.4. These data were analysed in the same way as in the error detection task. Again the good readers were faster than the poor readers ($min\ F'(1{,}44) = 12.49$, $p < 0.01$, one-tailed). Target words which did not fit the preceding semantic context were recognized at a slower speed (49 ms.), which was only significant in the analyses that took the subjects as the random factor ($F_s(1,38) = 8.94$, $p < 0.01$, one-tailed). The words which did not fit the syntactic context were recognized slower ($min\ F'(1,93) = 2.98$, $p < 0.05$, one-tailed). As far as the interactions between the various main effects are concerned none of the possible interactions were significant.

A word that has to be recognized in a context that is semantically and/or syntactically incoherent will be recognized rather slowly. Thus, the information used to detect the error will become available slowly, which in its turn will lead to relatively slow error detection times. To compensate for these slow recognition times it is sensible to measure the detection time from the moment the words are recognized. When the influence of the context on word recognition (i.e. the mean recognition time when both the semantic and syntactic context are correct minus the measured mean recognition time in a given condition) is eliminated by subtracting this influence from the measured error detection times, this leads to the *real* detection times. These data are presented in Table 7.5.

The Friedman two-way analysis of variance by ranks test on these data showed that the factor context (levels: syntactically and semantically acceptable, syntactically incorrect and semantically acceptable, syntactically acceptable and semantically incorrect, and syntactically incorrect and semantically incorrect) was significant for the good readers ($\chi^2 r(6) = 9.18$, $p < .05$), the poor readers ($\chi^2 r(6) = 10.50$, $p < .02$), and the total group of readers ($\chi^2 r(6) = 19.65$, $p < .001$). The results for the good readers and the poor readers are fairly similar. Three comparisons were made to test the one-tailed expectations that the errors that were syntactically and semantically acceptable would be detected slower than the errors in the other conditions. (i) The errors which were syntactically and semantically acceptable were detected more slowly than the errors that were syntactically incorrect and semantically acceptable (N = 19, $x = 6$, $p = .084$ for good readers; N = 20, $x = 6$, $p = .058$ for poor readers; and N = 39, $z = 2{,}56$, $p < .001$ for all readers). (ii) The errors which were syntactically and semantically acceptable were detected more slowly than the errors that were syntactically acceptable and semantically incorrect (N = 20, $x = 4$, $p < .01$ for good readers; N = 20, $x = 5$, $p < .05$ for poor readers; and N = 40, $z = 3.64$ $p < .001$ for all readers). (iii) The errors which were detected when they were syntactically and semantically acceptable were detected more slowly than the errors that were syntactically incorrect and semantically incorrect (N = 20, $x = 6$, $p = .058$ for good readers; N = 20, $x = 4$, $p < .01$ for poor readers; and N = 40, $z = 3.32$ $p < .001$ for all readers).

readers	the context for the error is			
	semantically acceptable		semantically incorrect	
	syntactically		syntactically	
	acceptable	incorrect	acceptable	incorrect
good readers	585+(0)= 585	608+(-50)= 558	540+(-38)= 502	587+(-68)= 519
poor readers	781+(0)= 781	811+(-67)= 744	719+(-96)= 623	774+(-111)= 663

Table 7.5 Mean *real* detection times [ms] for words presented in various contexts (Experiment VIII)

It may be concluded that whenever context provides information for the detection of an error, this will lead to a fast detection time when the effect of the context on the word recognition is eliminated.

7.3.3 Discussion and conclusions

The question of whether a word is coherent within the preceding syntactic or semantic context plays an important role in the detection of reading errors. If an error does not fit the preceding context two effects can be observed: recognition is inhibited and detection is facilitated. Only if reaction times are split up into a recognition part and an error detection part is it clear that both syntactic and semantic information is used in error detection: errors that are semantically and syntactically acceptable, are detected more slowly than errors that are not syntactically and/or semantically acceptable.

Somewhat surprisingly, the combination of the two types of context information does not lead to a faster reaction time than the presence of syntactic or semantic information alone. A number of explanations can be given for this finding. It is possible that the syntactic information is always available simultaneously with, or later than, the semantic context information. In that case the syntactic information is not able to play a role when errors are detected by use of the semantic information. Another possibility is that the *process monitor* is not able to react any faster than the fastest times found in the experiment. Other explanations are also possible. The findings of the experiment are not sufficient to confirm any single explanation.

The results support a model of error detection in which the detection mechanisms are closely connected to processes involved in the perception and production of language. In the experiment various types of information were used to detect errors: the syntactic context information, the semantic context information, and - when there was no context clue for error detection – the phonemic and semantic information of the words.

In the experiments, a number of errors could only be detected by a comparison between the target and the realized word: those errors which fitted the context could be detected by comparing the letters/sounds or the meanings. The fact that these errors were detected proves that there must be devices such as the *double way* or *two way error detection* mechanism, since these mechanisms are able to compare information. Whenever errors were detectable on the basis of a contextual incoherence, they were detected faster than errors which were not detectable on the basis of this information. This finding can be interpreted as supporting another detection device: the *no result error detection* mechanism, since this device is able to detect linguistically incorrect errors.

Although the poor readers were not as fast as the good readers in the detection of the experimentally presented errors, none of the results in the experiment suggested a difference between good and poor readers in their use of the context to detect errors. Differences found between good and poor readers in the use of context (chapter 3 and 4), must be based on a difference in *availability* of the context and not in *use* of the context for error detection.

One remark should be made with respect to the word monitoring task. No reading is involved in that task. However, the difference between the good and poor readers' reaction times is still about 300 ms. This huge difference in a word monitoring task suggests that the latter have problems in accessing the information present in their mental lexicon. It is a relatively time-consuming task for the poor readers to extract such information as the word meaning and the word class from the auditory presentation of the target. The present experiments show that the main problems of the poor readers have nothing to do with error detection, or with the use of syntactic and semantic context information. Their main problems need not even lie in the processes that are responsible for the extraction of words from an input which consists of letters; the difference between good and poor readers is smaller in the detection task where reading is involved (191 ms.). In other words, their reading problem is not actually a reading problem. Their main problem seems to be the difficulties that they have in accessing the several types of information, which are needed in the word monitoring task. This general language shortcoming leads to a reading problem but is not a problem specific to the activity of reading.

Chapter 8 General discussion.

This study presents a set of experiments on self-correction in reading. Attention is focussed on two issues: how errors are detected when reading a text, and in what way good and poor readers differ in this respect.

The topics under investigation can be formulated in terms of a number of questions. Given that reading errors are the result of an accidentally incorrect handling of information by one or more of the processes involved in the analysis and production of language, what processes or mechanisms have to be postulated that make the detection of reading errors possible? What information is used to detect errors? How are multiple types of information combined in the detection of errors? What are the differences in the error detection behaviour of good and poor readers? What are the consequences of the present study for the treatment of poor readers? The main conclusions in answer to these questions are presented in the following sections.

8.1 Error detection mechanisms.

A starting point for a model of error correction was that the results of a process can be evaluated using two criteria: (i) is there any result at all, and (ii) are the results the same if they are obtained a second time? These criteria seem to be straightforward. Other types of evaluation would presuppose error detection processes which are capable of performing, at least partly, the same analyses or conversions as those that are carried out by the process that produces the input for the error detection process itself. It does not seem likely, from an economical point of view, that control processes are structured in a way that is at least as complicated as the process they should control. It seems to be more economical to take advantage of the information which is generated by the various processes involved in the language system.

On the basis of these considerations, various simple error detection processes or mechanisms were postulated. In the *double* or *two way error detection* mechanism the output from a particular process is checked to see whether it matches a previously generated output. Such previous results may be generated by a faster parallel process or in a preceding stage. Necessary conditions for the proper functioning of these mechanisms are (i) a memory in which previously produced results are stored and (ii) a positional pointer or label for each produced element so as to make it possible to decide for which objects a similarity check should be carried out (if pointers are equal, a similarity check should be carried out). If elements differ in spite of the fact that they have the same pointers, an error must have occurred. That elements or structures can be available after a short period is shown by a number of studies (e.g. Bock, 1986; Levelt & Kelter, 1982). This type of error detection can be performed at low 'processing costs' since its input consists of results that are generated by processes which have to work anyway to read a text aloud. Another simple error mechanism is the *no result error detection* process. This mechanism only has to keep track of the time delay between the moment a given process received its input and the moment a result is produced. If a given time delay is exceeded, an error must have occurred.

It may be assumed that only initial overt input (letters on paper) and final overt output (the sounds produced) are subject to the error detection mechanisms. However, there are a number of advantages in checking the intermediate results of the processes involved in the production and perception of linguistic material when reading. An increase in the number of places within the language system where a check for errors is performed will lead to an increase in the incidence and speed of error detection. This means that apart from a *perceptual way of monitoring*, a *production way of monitoring* would also have some advantages for efficient language processing (both ways are presented in Levelt, 1983). If one accepts that errors are detected by the mechanisms proposed in this study, it may be clear that error checking in the productional stage can be performed at low cost. However, as argued in chapter 2, it is very difficult to find empirical evidence on this issue.

As a consequence of the assumption that error detection mechanisms can operate on a great number of processes, it must be further assumed that there is a central control process which handles the signals from the individual error detection mechanisms. Chaos would result if the flow of information within the language system could be interrupted or even redirected from many points within the system by the various error detection mechanisms. The central *process monitor* may react in a number of different ways to signals from different error detection mechanisms. It may also disregard certain signals, for instance if certain processes fail to produce a result due to certain characteristics of the input signal. For example, when reading a word list, no syntactical structure will be built. However, the failure of the process to build such a structure may be overlooked. The *process monitor* may be considered an important controlling device of the complete mental language system. It should be noted that such a central monitor is the normal device postulated to account for error correction (e.g. Levelt, 1983).

8.2 The information for error detection.

If error detection mechanisms work on processes that produce intermediate results during reading, it is of interest to determine what processes are subject to the error detection mechanisms. An error can be characterized by specifying which particular linguistic information is not correctly realized. For errors that are linguistically unacceptable this can be done by specifying in which linguistic aspects the error is unacceptable. For other errors this can be done by comparing the error and the target word and determining in which linguistic aspects the error deviates. One can then investigate whether errors which are unacceptable or different with respect to a certain type of information have a greater chance of being corrected than errors where this information cannot be used for error detection. To discover what type information plays a role in the detection of errors, a collection of spontaneous errors and self-corrections was compiled from the reading of good and poor readers (chapter 3). It turned out that a number of types of information played a role in the detection of their reading errors. The incidence of detection was influenced by the similarity in letters and sounds between error and target, the similarity in word class and the similarity in word meaning. When an error consisted of inappropriate information with respect to word class, word meaning, syntactic context or semantic context, the chance of correction was increased.

These investigations (chapter 3) made it plausible to suggest that both types of error detection mechanism play a role in the correction of errors. Indeed, if an error could be detected because of inadmissibility this increased the chances of detection. Similarly, if an error could be detected because of a difference with respect to the target word, the chance of detection increased again. Furthermore, the detection mechanisms work on a number of the processes involved in reading, i.e. on the processes regarding letters, sounds, word class, word meaning, syntactic context and semantic context. One type of information which did not seem to play a role in the detection of errors was morphological information. An explanation for this could be that within the language processing system this information is not considered to be important, and the detection of such errors is ignored by the *process monitor*. However, such an explanation seems a little feeble.

A second way of investigating the types of information used in detecting errors has to do with the delay which can sometimes be observed between the error and the moment of interruption before correction (chapter 4). Whenever the above types of information were available, suggesting that an error had occurred, the delay was shorter (the error was detected faster) than for errors where this information was not available.

There were some problems in these analyses. It is very difficult to study the role of an individual source of information in correction behaviour: nearly always, more than one source for detection is present in the errors. Moreover, when an error appears incorrect with respect to a certain type of information, this information may nevertheless be processed correctly and, conversely, correct realization with respect to one type of information does not necessarily imply that information was correctly processed (experiment I). These problems can be solved by experiments which allow manipulation of the types of information.

Experiments (II and III) in which the syntactic and/or semantic context information was removed showed that these two types of information both play their own role in correction behaviour. It turned out that if a reader meets problems in building a coherent context, he will pay more attention, which will result in more corrections. However, if it is very difficult or even impossible to build a context, this will lead to a drop in correction behaviour. A subsequent experiment (V) also showed that the error detection task can be intensified or, conversely, carried out in a very global fashion, as a function of the properties of the reading material, in particular the increasing difficulty of texts. If a text is far too difficult, this will not only decrease the proportion of errors that will be detected but also increase the number of detected errors that will not be corrected. To put it more generally: these experiments showed that the use of the context for error detection/correction is strongly influenced by the ease or difficulty with which this information can be extracted from a text. Texts may not only be too difficult but also too easy.

8.3 Interaction of information for error detection.

A *process monitor* is postulated in the present model of error detection. It receives signals from various independently operating error detection processes that are attached to the individual processes involved in the analysis and production of language. This device, then, has the possibility to decide at what point certain action should be carried out if an error occurs. The *process monitor* may receive error signals from several independently operating processes. The question then is whether multiple sources of information for the detection of errors are actually used. Analyses which considered this issue (chapter 3), indicated that there was no increase in the incidence of self-corrections when more sources became available for use. Explanations for these findings were formulated in terms of the characteristics of the errors in the corpus: the errors were closely interrelated with respect to the different types of information and therefore it was very difficult to decide how much variation in the self-correction behaviour was caused by a single information source.

In the experiments involving systematic manipulation of the information sources, the effects of combining sources of information were studied. In these experiments (VI and VIII) errors that could be detected on the basis of semantic or syntactic context as well as other 'low level' sources of information (letters/sounds and word meaning) were detected faster than the errors only detectable on the basis of the letters/sounds and word meaning. However, the combination of the two types of context information did not lead to a decrease in the error detection time. What caused this lack of decrease (e.g. a ceiling effect) is not yet clear.

Since the functioning of the error detection mechanisms depends on the functioning of the processes involved in reading, the absence of a certain type of information, or the incoherence of a sentence, can lead to a decrease in the speed of processing and hence to a decrease in the speed of error detection. If an error can be detected on the basis of several sources of information, the detection will not only be influenced by the information available but also by the problems which the language system encounters in processing the error. These different effects of context incoherence (slower word recognition, faster error detection) occur in two different tasks (experiment VIII).

8.4 Differences between good and poor readers.

A striking conformity is found between the self-correction behaviour of good and poor readers. Although good readers correct a greater proportion of their errors than poor readers, there is no fundamental reason to assume that poor readers really differ from good readers in their self-correction behaviour. A brief outline of the similarities between the self-correction behaviour of good and poor readers follows. Subsequently a number of explanations – all based on the difference in reading ability – will be given for the few differences in self-correction behaviour that remain.

Good and poor readers use the same sources of information to detect their errors (e.g. all readers used word class and ignored morphological structure). For both groups of readers the self-correction behaviour is related to the difficulty of the text (experiment V). The absence or presence of context information leads to the same consequences for all readers in terms of detection time (experiments VI and VIII). If an error leads to an incoherent syntactic and/or semantic context, this in turn leads to inhibition with respect to word recognition and to facilitation with respect to error detection when compared to errors that do not cause incoherence of the context.

The difference between the proportions of self-corrections made by good and poor readers can be attributed to a difference in the information available for error detection and to a difference in the decoding ability used to repair the error. It is clear that, having discovered that a word has been read incorrectly, the most appropriate action is to decode the word again in order to achieve the correct realization. Given the high error rate of poor readers it is reasonable to assume that a second attempt (in most cases it involves a difficult word) will in a considerable number of cases result in an error once again. So even if good and poor readers detect exactly the same proportion of their errors, it may readily be expected that this will lead to a lower proportion of successful self-corrections by the poor readers.

Although poor readers' problems in realizing the actual repair explain a great deal of the difference in self-correction proportions between good and poor readers, a difference in detection rate was also found and had to be explained. The high error rate of the poor readers is again an important variable in this respect. Making a lot of errors will leave the reader with a poor context, and thus less information to detect errors. Moreover, in absolute terms, poor readers correct more of their errors than good readers do. Having to correct so many instances and trying in vain to correct so many times, may encourage the reader to ignore a certain proportion of the errors detected.

Differences in the use of the context for error detection, as found in the analyses of the corpus of errors and corrections in chapters 3 and 4, can be explained by the *verbal efficiency theory* of Perfetti and his colleagues (Perfetti, 1985), according to which good and poor readers differ in the efficiency of word coding. Indeed, differences in context use between good and poor readers – resulting in differences in error detection proportion and mean length of delay – can be attributed to differences in the efficient operation of local processes. Decoding problems of poor readers - shown by the high error rate - reduce the quality of the available context. What kind of local processes fail to work properly is not yet clear, but the hypothesis that language-related problems arise at different levels from a common source which causes a 'computational bottleneck' with respect to working memory is highly plausible (LaBerge & Samuels, 1974; Stanovich, 1980). One potential source of trouble is, for instance, the part of the language system in which phonological information is processed. It is very plausible that reading is impaired if the memory system is constricted in handling phonological information (e.g. Brady, Shankweiler, & Mann, 1983; Shankweiler & Crain, 1986) The conclusion that poor readers do not differ from good readers in their ability to utilize the semantic content of written material seems to hold for linguistic units as large as complete sentences (this is the context information also investigated in this study; e.g. Schwartz & Stanovich, 1981), but also at the word level as can be observed in semantic priming procedures (e.g. Merril, Sperber, & McCauley, 1980; Simpson, Lorsbach, & Whitehouse, 1983, for low-ability readers; Schvaneveldt, Ackerman, & Semlear, 1977 for younger readers compared to older and better readers).

The findings in chapter 7 give a fair amount of support to the theories of *verbal efficiency*. Since experiments (VII) and (VIII) show that poor readers are at least as good as good readers in the use that they make of the semantic and syntactic context for detecting errors – provided that the reading activity can be performed at low cost – it may be assumed that the processes that handle contextual information do their work perfectly well. The error detection mechanisms are dependent on those processes. In other words:

the fact that contextual errors can be detected very well under certain circumstances shows that poor readers can process this type of information very well. That this information is used to a lesser degree when reading normal texts is probably caused by other, lower-order, processes.

8.5 Poor readers.

Children with severe reading problems are to a large extent able to detect their reading errors. However, after the detection of an error they still face the problem of how to decode a given sequence of letters correctly (i.e. to obtain the syntactic, semantic and word form information). This leads to the conclusion that poor readers should be taught how to decode difficult words. It is very important that they learn how to map letters onto sounds. The importance of this ability is stressed in studies such as Rozin and Gleitman (1977) and Liberman and Shankweiler (1979).

There are two ways to achieve the correct reading of a word. One way is to enlarge the readers' ability to decode difficult and new words, e.g. practising letter to sound conversion rules (for a discussion of the role of grapheme-to-phoneme correspondence rules in the acquisition of reading, see Barron, 1986). The second way is to provide the readers with correct context information. This may be illustrated by the results of the experiments in which the coherence of a text was manipulated. Good readers were offered a text which was scrambled to such an extent that the number of uncorrected errors rises considerably. On the other hand, good readers showed an increase in self-corrections when they met some moderate problems in reading a text which consisted of simple words. The conclusion of these findings must be that it is very important that the texts which are chosen to practise are of an appropriate level of difficulty. It is not very useful to practise a text which is too difficult (but at the same time often more interesting for the children). A solution which has already been applied is the talking books (Carbo, 1978; Dwarshuis, 1986; and van der Leij, 1983). In this method the child is supposed to read while listening to a tape recoder on which the text is presented. This method is closely related to the so-called Neurological Impress Method (NIM) (Heckelman, 1969). This method attempts to teach reading skills by having the pupil and the teacher read aloud together. However, effects are not always clear (e.g. Lorenz and Vockell, 1979). If it works, what are the reasons?

A learning situation in which two types of information (viz. letters and sounds) have to be processed simultaneously, as is the case with the NIM or the talking books, seems at first glance to be more complicated than reading without aural input. Why should such a complicated learning situation lead to good results? In the first place, processing the same information more than once is not unusual: in reading aloud, for instance, the same word is processed more than once at several stages. Moreover, the experiments of chapter 7 showed clearly that neither good nor poor readers have any difficulties in processing two types of verbal input simultaneously. Thus, the situation is not so difficult at all. In the second place, it may be claimed that double input means double information for processes such as word recognition. Thus, double input may increase the chances of correct recognition. Finally, the double input increases the availability of context information. As demonstrated in the experiments in which errors had to be detected on the basis of a comparison between visual and aural stimulus sentences, the context information is available to a great extent if the child has to read and at the same time hears how the words are read. This will increase the chance of correct decoding of the words.

On the basis of these considerations it can be suggested that a good practising technique is the application of the finding that poor readers are rather good at detecting errors. The task in the experiments (V) and (VII) (detecting errors in the reading of someone else) can be considered a beneficial practising task. If the learning situation consists of detecting errors in someone else's speech, they are confronted with a task which is less error-prone and frustrating than reading out a difficult text. The task will prevent the readers from being too passive. Furthermore, it is possible to control the practising without the intervention of a teacher. A micro-computer can keep track of the number of errors which are detected and register the time used to detect them.

Besides dealing with the question of what could be done for children with severe reading problems, the present study offers some evidence concerning the question of what should be avoided. No evidence was found to suggest that analyzing the reading product of individual poor readers allows direct inferences about what types of information are processed more or less successfully. If a child produces many errors that do not fit the preceding semantic context, this does not mean, necessarily, that he has real problems in using that type of context and that he needs special treatment in that respect. It may be possible that such a child has access to the correct word meanings all the time but fails to find the correct word form, and thus produces reading utterances which seem to be out of context.

An interesting area for further research would be the mental lexicon of poor readers. The word monitoring task in the last experiment reported in this study clearly shows that accessing information from the mental lexicon is difficult for the poor readers. It is not yet clear whether this is caused by a differential *structuring* of the lexicon (as suggested by e.g. Chabot, Petros, & McCord, 1983) or whether the *ways of accessing* the information are different for good and poor readers. Whatever the differences may be, it is clear that problems in accessing information from the lexicon, or problems with the incorporation of new information into that lexicon - e.g. with respect to information about the word form in terms of letters - can be very significant for the explanation and treatment of severe reading problems. However, it will be difficult to determine whether reading problems cause certain limitations of the lexicon or whether certain limitations cause the reading problem.

Poor readers perform worse than good readers in an number of areas presumably as the result of both the reading problem and the defect(s) in the information processing system that causes the reading problem (Stanovich, 1986). To know more about the real trouble of poor readers, it may be better to narrow down the real trouble spots in the language system that cause the reading problems by proving that many parts of the language system perform very well if they get the correct input. One potential trouble spot which works very well is the detection of reading errors: poor readers detect them most efficiently if adequate information is available.

8.6 "In silent reading I make fewer errors."

Although this study is primarily concerned with theoretical questions regarding reading problems, one may ask whether it can shed some light on observations made by teachers who work with poor readers. The theoretical ideas which are the result of this study may provide a background for what happens in everyday life when a poor readers tries to learn to read.

One of the frequent observations is that poor readers claim that they make more errors in oral reading than in silent reading. Although one can easily conclude that such a statement is difficult to verify – and in this study no empirical evidence is presented on the subject – it seems possible to infer a few motivated speculations about the bases for such statements. Thus, the question is: what leads to the statement: "When I read silently I make fewer errors than when I read aloud"?

In the first place, the child may look for an opportunity to defend itself. When reading aloud, it is horribly clear to everybody – including the child itself – that many errors occur. It seems natural that the child tries to defend itself by claiming that making so many errors must be partly due to the "extraordinary status" of reading aloud. As shown in chapter 6, when both the good and poor readers were not able to understand a certain text – in which the nouns were in the wrong places – the majority of the poor readers did not report this lack of understanding spontaneously, as the good readers did.

In the second place, it is possible that children do indeed make fewer errors when reading silently. This could be due to a smaller load on the resources of the language system when one task – reading aloud – is omitted. More time and energy can be used for the decoding and comprehending task. The speed will mainly be determined by the difficulty of the words, whereas in reading aloud the speed is also influenced by many other factors: the intonation contour, articulatory problems, etc. Moreover, since there are fewer processes involved, there are fewer places where an error can possibly occur. Finally, it is possible that for some words information with respect to the phonemes and sounds is not processed to the same extent as when reading aloud. Some proficient adult Dutch readers claim that they read and understand translated Russian books without knowing the – difficult – names of the main characters in the book. They recognize the letter patterns which denote the persons but do not bother about the pronunciation. It may be clear that in such cases no error can occur with respect to the phonemes and sounds. In the experiments in chapter 7, in which the readers only had to read and listen but did not need to produce language themselves, the poor readers did very well: like the good readers they detected all the errors and to the extent that they were slower, this was also the case when listening (which might indicate that the problem is not exclusively related to the reading task). In particular, their problems in using the context disappeared.

In the third place, a reader may detect fewer of his errors when reading silently. In the model presented in chapter 2, many of the errors can be detected by comparing intermediate results that should be equal. When reading silently the productional stage and second analyzing stage are omitted, and this will lead to fewer products that can be compared. When reading silently the comparison between written input and oral output is not possible and as demonstrated in chapters 3, 4, and 7, this is a very useful source of error detection. Hence, in silent reading error detection will be poorer due to fewer information sources. However, it is possible that the reader compensates for this to some extent by producing and analyzing inner speech.

To summarize the discussion of the poor readers' claim that they make fewer errors when reading silently, it can be said that despite the fact that such a claim is easy to make and difficult to verify, it is in all probability correct – partly because, due to a smaller load on the resources of the language system, they do indeed make fewer errors, and partly because, with less information available for self-monitoring, they also detect fewer errors.

Summary

This study attempts to investigate how children detect and correct their errors when reading aloud and to what extent children with severe reading problems behave differently in this respect from children who learn to read well.

Chapter 1 describes the children whose reading was investigated and how researching reading errors and self-corrections leads to insight into the reading process. The readers participating in the investigations can be divided into two categories: good readers of 10 and 11 years old, who are learning to read well, and poor readers of the same age. The poor readers' progress is at least 2 years behind the good readers. They are nevertheless comparable to good readers with respect to physical health, intelligence, emotional stability, social background, received education, etc. The findings presented in the literature about severe reading errors do not provide a clear answer as to how they are caused. Furthermore, it is unclear which parts of the information processing system of children with reading problems work well, which parts are inadequate as the result of the reading problem and which parts are inadequate and lead to reading problems. However, researchers agree on the assumption that the main problems have to be located in the mental processing of linguistic information rather than in the more periferal processes like the processing of the visual input.

Poor readers correct a smaller percentage of their reading errors than good readers. It is important to investigate why this is so because it is reasonable to assume that practising by poor readers is less effective compared to good readers as a consequence of the smaller percentage of corrections. However, more important is that research of self-correction behaviour provides insight into the availability of various forms of linguistic information in reading. Basically, many types of lingustic information can be used for the detection of errors in reading (e.g. morphological information, syntactic information, semantic information, context information, etc.). Whether poor readers differ from good readers in the use of a number of sources of linguistic information for the detection of reading errors is investigated in this study.

In **Chapter 2** the main reading models are presented along with a model for the detection of errors in reading. The main conclusion of the discussion of the reading models is that reading is carried out on the basis of a number of parallel and autonomous operating processes, resulting in the presence of a great number of different forms of linguistic information within the language system. How this information may be used in detecting errors is explained in a model for the detection of errors. This model is based on three mechanisms: one that decides whether processes yield a product in time (the so-called *no result* error detection mechanism), one that decides whether two products are identical if they are produced twice by the same process (the so-called *double way* error detection mechanism) and one that decides whether products are identical when they are produced by different processes that should yield the same output (the so-called *two way* error detection mechanism). By means of the first mechanism it is for instance possible to detect that a sentence which is read aloud is syntactically inadmissible (the syntactic process cannot find an analysis). The second mechanism leads to the detection that, for instance, the syn-

tactic structure of the sentence which was read aloud differs from the syntactic sentence which was seen on the page. In reading aloud it is assumed that a sentence is read from the paper and subsequently re-produced for reading aloud; this output is then again input for processing. A comparison of products that appear in these phases of reading aloud can be made by help of the second and third mechanisms. The third mechanism may detect that the phonemes which are initially activated in reading differ from the phonemes which emerge when the reading is produced aloud (when reading a sentence, phonemes are initially activated by grapheme/phoneme conversion; when this sentence is produced aloud phonemes emerge by looking up a word form in the lexicon, and the results should be identical in both cases when the same word is involved).

Chapter 3 considers a number of linguistic types of information and investigates whether they play a role in the detection of errors. This is done by examining a large collection of reading errors and self-corrections to see whether errors that are incorrect with respect to a certain type of information, e.g., word class, are corrected to a greater extent than errors where this information is used correctly. The discrepancy between target word and error in letters/sounds, word class, and meaning is used for the detection of errors by both good and poor readers. When word class, word meaning, syntactic structure or meaning structure cannot be assigned due to the production of an error, this is an occasion for all readers to correct the error. However, poor readers are not as good in using information based on the coherence of the syntactic and semantic context as good readers. An increase in the number of sources of information indicating that a certain word has been read erroneously, does not lead to an increase in the number of corrections for either group of readers (e.g. when 'house' is read as 'cry', the letters/sounds, the word class, and the meaning are incorrect and may serve as indicators that an error occured).

Chapter 4 investigates whether the moment a reader stops to correct an error depends on the information he has at his disposal to detect it. In addition, the relation between the so-called 'editing terms' and the nature of the error is studied. Finally, the question of whether the syntactic stucture of the sentence determines the starting point of the actual correction in the sentence is examined.

The extent to which the error deviates from the target word in terms of letters/sounds seems to have no influence on the moment the readers stop in order to correct. Good readers, however, stop their reading aloud sooner in order to correct whenever the error deviates in meaning from the target word or whenever no meaning can be found. When an error immediately causes the sentence to be semantically or syntactically uninterpretable, this also leads to a fast correction by good readers. These findings show that there is a clear relation between the moment one stops in order to correct and the moment an error is detected. Again, in this analysis poor readers appear to be less sensitive to semantic and syntactic context information then good readers.

The 'editing terms' do not play a role in the corrections of good and poor readers.

In order to correct, readers sometimes go back to a point in the sentence before the wrongly realised target. This is mainly the case when a syntactically important starting point, such as the beginning of a sentence, is near by. The beginning of a sentence, clause or noun phrase is a preferred place to start a correction. Poor readers behave differently in this respect when the syntactic structures are relatively difficult to distinguish.

The difference between good and poor readers in the use of context for the detection of errors may be accounted for by a difference in availability of the contextual information. One may then assume that poor readers are equally good as good readers in the use of context information for the detection of errors, but that they have less context information at their disposal due to their great decoding problems.

In **Chapter 5** some problems arising from the research presented in the preceding chapters are dealt with. An error is usually incorrect with respect to more than one type of linguistic information. It is, therefore, difficult to determine accurately the effect of individual types of information on the detection of errors. Moreover, errors do not need to mirror exactly the problems that caused the emergence of the error inside the language system. An experiment on this topic showed a dramatic discrepancy for poor readers between the errors that were made and the available information. For instance, when a poor reader reads the word 'bark' as 'thieves' he is able in quite a number of cases to decide that the target word had something to do with 'dog'.

Chapter 6 describes experiments in which the individual role of different linguistic sources such as syntactic and semantic context information in the detection of errors is investigated. When good readers have to read a text that is semantically incoherent, they are more alert, as is revealed by a greater number of corrections. Thus, the lack of coherence in semantic context forms a constant alarm. For poor readers, however, this effect was not obtained. When good and poor readers have to read a text which is both semantically as syntactically incoherent, the number of self-corrections decreases. The explanation may be that this severe incoherence makes so reading difficult that little information and few mental resources are available for correction. Good and poor readers show the same correction behaviour in case of severe incoherence. An experiment in which the level of difficulty of texts was varied made it clear that whenever a reader is confronted with great difficulties in reading, the number of self-corrections decreases. This finding offers an explanation for the moderate correction behaviour usually found for poor readers. Probably there exists an optimal level of difficulty, in which a maximal number of errors is detected and corrected.

Chapter 7 examines whether good and poor readers detect reading errors *faster* if they can use context. By means of an experiment in which words constituting a sentence were presented simultaneously on a screen and via a tape recorder, it was possible to investigate whether errors are detected faster when semantic context can be used. If an error can be detected on the basis of semantic context, this leads to a fast error detection. A second experiment investigated whether both semantic and syntactic context can lead to relatively fast error detection. In addition measurements were made to discover whether the error – if it did not fit the preceding semantic and/or syntactic context – resulted in slow recognition of the auditorial signal (it was assumed that a reader can only decide that a word does not fit the preceding context when it has first been recognized). So, the effects of the context on recognition and error detection are measured independently. It turns out that if an error does not fit the preceding context, the detection is delayed because of the relatively slow recognition of the erroneous word, but on the other hand the detection is speeded up because the context provides information that an error has appeared.

Good and poor readers do not really differ in the use of context in these experiments. They do differ in the speed of word recognition, both visually and auditorially.

In **Chapter 8** research findings are discussed, and there are two main conclusions. In the first place, the model of error detection is supported in both the investigations of the collection of errors and corrections as well as the experimental research. The detection of reading errors is based on the use made of a number of different types of linguistic information by various error detection mechanisms. In the second place, poor readers have no problems in using context for the detection of errors. The latter conclusion can even be extended: poor readers are – given their reading proficiency – well able to correct their errors.

Samenvatting

In deze studie wordt onderzocht hoe kinderen hun fouten bij hardop voorlezen ontdekken en corrigeren, en in hoeverre kinderen met ernstige leesproblemen hierin afwijken van kinderen die voorspoedig leren lezen.

In **hoofdstuk 1** wordt duidelijk gemaakt over welke kinderen het gaat en op welke wijze onderzoek naar leesfouten en zelfcorrecties inzicht kan verschaffen in het leesproces. De lezers die deelnemen aan het onderzoek zijn in te delen in twee categorieën: goede lezers van 10 en 11 jaar die voorspoedig leren lezen en slechte lezers van dezelfde leeftijd. De slechte lezers vertonen een achterstand van minimaal 2 jaar in lezen op hun leeftijdsgenootjes. Wat algemene leervoorwaarden betreft zoals fysieke gezondheid, intelligentie, emotionele stabiliteit, sociale achtergrond, aantal jaren onderwijs, etc. zijn de slechte lezers echter te vergelijken met de goede lezers. De bevindingen die gepresenteerd worden in de literatuur over ernstige leespro-blemen geven geen uitsluitsel over de oorzaak ervan. Het is evenmin duidelijk welke delen van het informatie verwerkend systeem van kinderen met leesproblemen goed werken, welke gebrekkig werken ten gevolge van het leesprobleem en welke gebrekkig werken en leiden tot het leesprobleem. Onderzoekers stemmen echter overeen in de aanname dat de belangrijkste problemen zijn gelocaliseerd in de mentale verwerking van talige informatie en niet liggen bij meer perifere processen zoals de verwerking van visuele invoer.

Slechte lezers corrigeren een kleiner percentage van hun leesfouten dan goede lezers. Het is van belang te onderzoeken wat hiervan de oorzaak is, omdat mag worden aangenomen dat het oefenen door slechte lezers hierdoor minder effectief is dan van goede lezers. Belangrijker is echter dat onderzoek van zelfcorrectief gedrag inzicht kan verschaffen in de beschikbaarheid van diverse vormen van talige informatie bij het lezen. Voor de detectie van fouten bij het lezen kunnen in principe vele soorten talige informatie worden benut (b.v. morfologische informatie, syntactische informatie, semantische informatie, context-informatie, etc.). In deze studie is onderzocht of slechte lezers afwijken van goede lezers in het gebruik van een aantal bronnen van talige informatie voor detectie van leesfouten.

In **hoofdstuk 2** wordt een schets gegeven van de belangrijkste leesmodellen. Tevens wordt een model gepresenteerd voor de detectie van fouten bij het lezen. De belangrijkste conclusie van de bespreking van de leesmodellen is dat lezen gebeurt op basis van een aantal parallel en autonoom verlopende processen, waardoor er binnen het taalsysteem een groot aantal verschillende vormen van informatie een rol speelt. Hoe van deze informatie gebruik gemaakt kan worden om fouten op te sporen wordt uiteengezet in een model voor de detectie van leesfouten. Dit model is gebaseerd op drie mechanismen: één dat beslist of processen tijdig een produkt afleveren (het zogenaamde **geen resultaat** fout detectie mechanisme), één dat beslist of twee produkten gelijk zijn als ze voor een tweede keer door hetzelfde proces worden gegenereerd (het zogenaamde **dubbele weg** fout detectie mechanisme) en één dat beslist of produkten gelijk zijn, die ontstaan door de werking van verschillende processen waarvan de uitvoer hetzelfde produkt zou moeten opleveren (het zogenaamde **twee weg** fout detectie mechanisme). Door het eerste mechanisme kan bijvoorbeeld ontdekt worden dat een voorgelezen zin syntactisch niet klopt (het syntactische analyse proces kan geen analyse vinden). Het tweede mechanisme kan leiden tot de ontdekking dat bijvoorbeeld de syntactische structuur van een voorgelezen zin afwijkt van de syntactische structuur van de zin die gelezen moest worden. De veronderstelling is dat de zin op papier gelezen wordt en dan hardop uitgesproken wordt; deze uitvoer vormt weer invoer voor verwerking. Vergelijkingen van producten die ontstaan tijdens deze drie stadia kunnen gemaakt worden met behulp van het tweede en derde mechanisme. Het derde mechanisme zou kunnen ontdekken dat de fonemen die zijn opgeleverd bij het lezen, afwijken van de fonemen die worden opgeleverd bij het hardop produceren van het gelezene (bij het lezen worden fonemen opgeleverd door grafeem/foneem omzettingen; bij het uitspreken worden fonemen opgeleverd door het opzoeken van een woordvorm in het lexicon; het resultaat zou voor hetzelfde woord gelijk moeten zijn).

In **hoofdstuk 3** wordt van een aantal vormen van linguïstische informatie onderzocht of zij een rol spelen bij het opsporen van fouten. Dit gebeurt door in een grote verzameling leesfouten en zelfcorrecties te onderzoeken of fouten die incorrect zijn met betrekking tot een bepaald type informatie, b.v. woordklasse, veelvuldiger worden ontdekt dan fouten waarin deze informatie correct gerealiseerd is. Discrepantie tussen doelwoord en fout in letters/klanken, woordklasse en betekenis blijkt benut te worden voor de detectie van fouten door zowel goede als slechte lezers. Indien het niet mogelijk is een woordklasse, een woordbetekenis danwel een syntactische of semantische zinsstructuur af te leiden na de produktie van een fout, dan kan dit voor alle lezers aanleiding zijn tot correctie. Maar slechte lezers maken in mindere mate gebruik maken van de syntactische en semantische context. Een toename in het aantal bronnen van informatie dat een bepaald woord fout is gelezen, leidt voor beide groepen lezers niet tot een toename van de correcties (b.v. wanneer 'huis' wordt gelezen als 'huil' zijn zowel de letters/klanken, de woordklasse als de betekenis fout gerealiseerd en kunnen deze drie vormen van informatie elk leiden tot detectie van de fout).

In **hoofdstuk 4** wordt onderzocht in hoeverre het moment waarop een lezer stopt om een fout te corrigeren, samenhangt met de informatie die de lezer heeft om de fout op te sporen. Voorts is nagegaan of zogenaamde "editing terms" meer verduidelijken over de aard van de fout. Tenslotte is onderzocht of het punt in de zin waar de feitelijke correctie begint syntactisch is gemotiveerd.

De mate waarin de fout afwijkt van het doelwoord in letters/klanken lijkt geen invloed te hebben op de snelheid waarmee lezers stoppen om te corrigeren. Goede lezers blijken echter sneller te stoppen met voorlezen om te corrigeren als de fout afwijkt in betekenis van het doelwoord of indien geen betekenis kan worden toegekend. Indien een zin syntactisch of semantisch onmiddellijk oninterpretabel wordt ten gevolge van het optreden van een fout, dan leidt dit eveneens tot een snelle correctie door goede lezers. Deze bevindingen wijzen erop dat lezers stoppen op het moment dat de fout ontdekt wordt. Slechte lezers blijken in deze analyse wederom ongevoeliger te zijn voor semantische en syntactische context-informatie.

"Editing terms" blijken geen rol van betekenis te spelen in de correcties van goede en slechte lezers.

Om te corrigeren gaan lezers soms terug naar een punt in de zin vóór het woord dat fout werd gelezen. Dit blijkt vooral op te treden in de buurt van een syntactisch belangrijk punt, zoals het begin van een zin. Correcties blijken bij voorkeur te starten bij het begin van een zin, bijzin of noun phrase. Slechte lezers wijken hierin af van goede lezers als de syntactische structuur moeilijker te onderscheiden is.

Een verklaring voor het verschil in context-benutting voor foutdetectie tussen goede en slechte lezers is gelegen in een verschil in beschikbaarheid van deze informatie. Wellicht kunnen slechte lezers context-informatie even goed benutten voor het ontdekken van hun fouten als goede lezers, maar beschikken ze over minder context-informatie vanwege hun grote decodeerproblemen.

In **hoofdstuk 5** worden problemen met betrekking tot het voorheen gepresenteerde onderzoek aan de orde gesteld. Een fout is doorgaans incorrect met betrekking tot meerdere vormen van linguïstische informatie. Daardoor is het moeilijk om nauwkeurig vast te stellen wat het effect is van de afzonderlijke vormen van informatie op foutdetectie. Bovendien hoeft een fout geen exacte weerspiegeling te zijn van de problemen die binnen het taalsysteem geleid hebben tot het optreden van de fout. Het eerste experiment laat voor slechte lezers een drastische discrepantie zien tussen de fouten die de lezer maakt en de informatie die hij ter beschikking heeft. Als een slechte lezer bijvoorbeeld het woord "blaffen" leest als "boeven" is hij toch in een groot aantal gevallen in staat aan te geven dat het doelwoord iets met "hond" te maken heeft.

In **hoofstuk 6** wordt een aantal experimenten gerapporteerd waarin de rol van afzonderlijke bronnen als syntactische en semantische context voor het opsporen van fouten is onderzocht. Indien goede lezers een tekst moeten lezen die semantisch incoherent is, dan leidt dit tot een verscherpte waakzaamheid blijkend uit een groot aantal zelfcorrecties. Het gebrek aan coherentie in de semantische context vormt dus een constant alarm. Voor slechte lezers is dit effect niet aantoonbaar. Indien goede en slechte lezers een tekst moeten lezen die zowel semantisch als syntactisch incoherent is, leidt dit tot een daling in het aantal zelfcorrecties. De verklaring kan zijn dat deze ernstige incoherentie het lezen zodanig bemoeilijkt dat er weinig informatie en mentale capaciteit beschikbaar is voor correctie. Goede en slechte lezers vertonen bij ernstige incoherentie eenzelfde correctief gedrag. Een experiment waarin de moeilijkheidsgraad van teksten wordt gevarieerd, laat zien dat wanneer een lezer te grote moeilijkheden ondervindt in het lezen het aantal zelfcorrecties afneemt. Deze bevinding geeft een verklaring voor het matige correctiegedrag dat slechte lezers doorgaans vertonen als ze vergeleken worden met goede lezers. Waarschijn-lijk is er een optimale moeilijkheidsgraad waarbij een lezer een maximaal aantal fouten detecteert en corrigeert.

In **hoofdstuk 7** wordt onderzocht of goede en slechte lezers *sneller* voorleesfouten detecteren als ze gebruik kunnen maken van context. In een experiment waarin simultaan woorden van zinnen op een scherm en via een bandrecorder worden aangeboden, is onderzocht of de detectie van voorleesfouten sneller verloopt als de semantische context benut kan worden voor het opsporen van de fouten dan wanneer de semantische context geen aanwijzingen hiertoe geeft. Indien een fout op grond van de semantische context ontdekt kan worden, leidt dit tot een snelle foutdetectie. In een tweede experiment is onderzocht of zowel semantische als syntactische context kunnen leiden tot relatief snelle foutdetectie. Bovendien is gemeten in hoeverre de fout – indien deze niet paste in de voorafgaande semantische en/of syntactische context – traag herkend wordt in het auditive signaal (aangenomen werd dat een lezer pas kan besluiten dat een woord niet past in de voorafgaande context als het woord herkend is). Gepoogd is om deze effecten van de context op herkenning en op foutdetectie afzonderlijk vast te stellen. Het blijkt dat, indien een fout niet past in de voorafgaande context, het opsporen ervan enerzijds vertraagd wordt omdat de noodzakelijke herkenning van het foutieve woord traag verloopt door de niet passende context, maar anderzijds sneller verloopt omdat de niet passende context een aanwijzing vormt dat er een fout is opgetreden.

Goede en slechte lezers verschillen in deze experimenten niet wezenlijk in het benutten van context. Zij verschillen wel in de snelheid waarmee zij woorden herkennen, zowel visueel als auditief.

In **hoofdstuk 8** worden de bevindingen van het totale onderzoek besproken. Er zijn twee belangrijke conclusies. Op de eerste plaats vindt het model van foutdetectie steun in zowel het onderzoek van het corpus van fouten en correcties als in het experimentele onderzoek. Het ontdekken van leesfouten is gebaseerd op het benutten van een groot aantal verschillende vormen van linguïstische informatie door verschillende foutdetectie mechanismen. Op de tweede plaats hebben slechte lezers geen problemen met het benutten van context voor het opsporen van fouten. De laatste conclusie gaat nog verder: slechte lezers zijn – gegeven hun leescapaciteiten – uitstekend in staat hun fouten te corrigeren.

References

Aaronson, D., & Scarborough, H. S. (1977). Performance theories for sentence coding: Some quantitative models. *Journal of Verbal Learning and Verbal Behavior, 16*, 277-303.

Allen, P. D. (1976). Some general implications concerning specific taxonomy categories. In P. D. Allen & D. J. Watson (Eds.), *Findings of research in miscue analysis: Classroom implications*. Urbana: ERIC Clearinghouse on Reading and Communication Skills, National Institute of Education, National Council of Teachers of English.

Allen, P. D., & Watson, D. J. (Eds.) (1976). *Findings of research in miscue analysis: Classroom implications*. 70-75. Urbana: ERIC Clearinghouse on Reading and Communication Skills, National Institute of Education, National Council of Teachers of English.

Allington, R. L., & Fleming, J. T. (1978). The misreading of high-frequency words. *The Journal of Special Education, 12*, 417-421.

Allington, R. L., & Strange, M. (1977). Effects of grapheme substitutions in connected text upon reading behaviors. *Visible Language, 11*, 285-297.

Au, K. H. (1977). Analyzing oral reading errors to improve instruction. *The Reading Teacher, 31*, 46-49.

Baars, B. J. (1980). On eliciting predictable speech errors in the laboratory. In V. A. Fromkin (Ed.), *Errors in linguistic performance. Slips of the tongue, ear, pen, and hand* (pp. 307-318). New York: Academic Press.

Baars, B. J., & Motley, M. T. (1974). Spoonerisms: Experimental elicitation of human speech and errors. *Journal Supplement Abstract Service, Catalog of Selected Documents in Psychology, 4*, 63.

Baars, B. J., & Motley, M. T. (1976). Spoonerisms as sequencer conflicts: Evidence from artificial elicited errors. *American Journal of Psychology, 83*, 467-484.

Bakker, D. J. (1967). Temporal order, meaningfulness and reading ability. *Perceptual and Motor Skills, 24*, 1027-1030.

Bakker, D. J. (1979). Hemispheric differences and reading strategies: Two dyslexias? *Bulletin of the Orton Society, 29*, 84-100.

Barron, R. W. (1986). Word recognition in early reading: A review of the direct and indirect access hypothesis. *Cognition, 24*, 93-119. Barron, R. W., & Baron, J. (1977). How children get meaning from printed words. *Child Development, 48*, 586-594.

Bauer, D. W., & Stanovich, K. E. (1980). Lexical access and the spelling-to-sound regularity effect. *Memory and Cognition, 8*, 424-432.

Becker, C. A. (1976). Allocation of attention during visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 2*, 556-566.

Becker, C. A. (1980). Semantic context effects in visual word recognition: An analysis of semantic strategies. *Memory and Cognition, 8*, 439-512.

Beebe, M. J. (1980). The effect of different types of substitution miscues on reading. *Reading Research Quarterly, 15*, 324-336.

Biemiller, A. (1970). The development of the use of graphic and contextual information as children learn to read. *Reading Research Quarterly, 6*, 75-96.

Biemiller, A. (1977-1978). Relationships between oral reading rates for letters, words, and simple text in the development of reading achievement. *Reading Research Quarterly, 8*, 223-253.

Bock, J. K. (1986). Syntactic persistence in language production. *Cognitive Psychology, 18*, 355-387.

Boder, E. (1971). Developmental dyslexia: A diagnostic screening procedure based on three characteristic patterns of reading and spelling. In B. Bateman (Ed.), *Learning Disorders. Vol. 4*. Seattle: Special Child Publications.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology, 15*, 663-687.

Bon, W. H. J. van (1984). *Aspecten van taalvaardigheid*. Lisse: Swets & Zeitlinger.

Bon, W. H. J. van (1985). De relatie tussen mondelinge taalvaardigheid en lees- en schrijfproblemen [The relation between oral verbal proficiency and reading and writing problems]. *Logopedie en Foniatrie, 57*, 278-284.

Bon, W. H. J. van, & Schreuder, R. (1986). Fonemische analyse: Het effect van woordkenmerken [Phonemic analysis: The effect of word characteristics]. In P. Reitsma, A. G. Bus & W. H. J. van Bon (Eds.), *Leren lezen en spellen. Ontwikkelingen en problemen* (pp. 24-31). Lisse: Swets & Zeitlinger.

Bos, K. P. van den (1984). Letter processing in dyslexic subgroups. *Annals of Dyslexia, 34*, 179-193.

Bouma, H., & Legein, Ch. P. (1980). Dyslexia: A specific recoding deficit? An anlysis of response latencies for letters and words in dyslectics and average readers. *Neuropsychologia, 18*, 285-298.

Bowey, J. A. (1984). The interaction of strategy and context in children's oral reading performance. *Journal of Psycholinguistic Research, 13*, 99-117.

Brady, S., Shankweiler, D., & Mann, V. (1983). Speech perception and memory coding in relation to reading ability. *Journal of Experimental Child Psychology, 35*, 345-367.

Brown, B., Haegerstrom-Portnoy, G., Adams, A. J., Yingling, C. D., Galin, D., Herron, J., & Marcus, M. (1983). Predictive eye movements do not discriminate between dyslexic and normal children. *Neuropsychologia, 21*, 121-128.

Brown, R., & McNeill, D. (1966). The 'tip of the tongue' phenomenon. *Journal of Verbal Learning and Verbal Behavior, 5*, 325-337.

Brus, B. Th., & Voeten, M. J. M. (1973). *Een-Minuut-Test, Vorm A en B* [One-Minute-Test]. Nijmegen: Berkhout Testmateriaal.

Bryant, P., & Impey, L. (1986). The similarities between normal readers and developmental and acquired dyslexics. *Cognition, 24*, 121-137.

Carbo, M. (1978). Teaching reading with talking books. *The Reading Teacher, 32*, 267-275.

Carr, T. H., Davidson, B. J., & Hawkins, H. L. (1978). Perceptual flexibility in word recognition. Strategies affect orthographic computation but not lexical access. *Journal of Experimental Psychology: Human Perception and Performance, 4*, 678-690.

Carr, T. H., & Pollatsek, A. (1985). Recognizing printed words: A look at currect models. In D. Besner, T. G. Waller & G. E. MacKinnon (Eds.), *Reading research. Advances in theory and practice. Vol. 5* (pp. 1-82). New York: Academic Press.

Chabot, R. J., Petros, T. V., & McCord, G. (1983). Developmental and reading ability differences in accessing information from semantic memory. *Journal of Experimental Child Psychology*, *35*, 128-142.

Clark, H. H., & Clark, E. V. (1977). *Psychology and language. An introduction to psycholinguistics.* New York: Harcourt Brace Jovanovich.

Clark, H. H., & Haviland, S. E. (1977). Comprehension and the given-new contract. In R. O. Freedle (Ed.), *Discourse production and comprehension.* Norwood: Ablex Publishing.

Clay, M. M. (1968). A syntactic analysis of reading errors. *Journal of Verbal Learning and Verbal Behavior*, *7*, 434-438.

Cohen, A. (1980). Correcting of speech errors in a shadowing task. In V. A. Fromkin (Ed.), *Errors in linguistic performance. Slips of the tongue, ear, pen, and hand* (pp. 157-163). New York: Academic Press.

Cole, R. A. (1973). Listening for mispronunciations: A measure of what we hear during speech. *Perception & Psychophysics*, *1*, 153-156.

Cole, R. A., & Perfetti, C. A. (1980). Listening for mispronunciations in a children's story: The use of context by children and adults. *Journal of Verbal Learning and Verbal Behavior*, *19*, 297-315.

Coltheart, M. (1978). Lexical access in simple reading tasks. In G. Underwood (Ed.), *Strategies of information processing* (pp. 151-216). New York: Academic Press.

Coltheart, M., Davelaar, E., Jonasson, J. T., & Besner, D. (1977). Access to the internal lexicon. In S. Dornic (Ed.), *Attention and performance. Vol. 6.* Hillsdale: Erlbaum.

Coltheart, M., Patterson, K. E., & Marshall, J. C. (1980). *Deep Dyslexia.* London: Routledge & Kegan Paul.

Cromer, W., & Wiener, M. (1966). Idiosyncratic response patterns among good and poor readers. *Journal of Consulting Psychology*, *30*, 1-10.

Cutler, A. (1980). Errors of stress and intonation. In V. A. Fromkin (Ed.), *Errors in linguistic performance. Slips of the tongue, ear, pen, and hand* (pp. 67-80). New York: Academic Press.

Daneman, M., & Carpenter, P. A. (1983). Individual differences in integrating information between and within sentences. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *9*, 561-584.

Dell, G. S. (1980). *Phonological and lexical encoding in speech production: An analysis of naturally occurring and experimentally elicited speech errors.* Unpublished doctoral dissertation, University of Toronto.

Dommerholt, I. (1970). *Differentiële zinnenleestest* [Differentiating sentence reading test] (3rd ed.). Groningen: H. D. Tjeenk Willink.

Dumont, J. J. (1984). *Lees- en spellingsproblemen. Dyslexie, disorthografie en woordblindheid* [Problems in reading and writing. Dyslexia, disorthographia, and word-blindness]. Rotterdam: Lemniscaat.

Dumont, J. J., & Janssens, J. M. A. M. (1983). De discrepantiehypothese getoetst [The discrepancy hypothesis tested]. *Tijdschrift voor Orthopedagogiek*, *5*, 255-268.

Dumont, J. J., Oud, J. H. L., Bekerom, F. L. M. H., Mameren-Schoehuizen, G. M. M. van, Mulder, M. M. D. de, & Zeelen, C. F. F. (1987). De dyslectische leerling in het voortgezet onderwijs [The dyslexic pupil in the continued education]. In L. M. Stevens & A. van der Ley (Eds.), *Dyslexie 86. Verslag van het congres over dyslexie,* *woordblindheid, lees- en schrijfstoornissen, gehouden in de Koninklijke Nederlandse Jaarbeurs te Utrecht op 17 en 18 juni 1986.* Lisse: Swets & Zeitlinger.

Dwarshuis, M. (1986). De kijk- en luistermethode. *Tijdschrift voor Orthopedagogiek, 25*, 470-479.

Foster, K. I. (1976). Accessing the mental lexicon.. In R. J. Wales & E. Walker (Eds.), *New approaches to language mechanisms* (pp. 257-287). Amsterdam: North-Holland Publishing Company.

Foster, K. I. (1979). Levels of processing and the structure of the language processor. In W. E. Cooper & E. Walker (Eds.), *Sentence processing: Psycholinguistic studies presented to Merrill Garrett.* Hillsdale: Erlbaum.

Freud, S. (1966). *Psychopathology of everyday life* (A. Tyson, Trans.). London: Benn. (Original work published in 1901)

Fromkin, V. A. (Ed.) (1973). *Speech errors as linguistic evidence.* The Hague: Mouton.

Fromkin, V. A. (Ed.) (1980). *Errors in linguistic performance. Slips of the tongue, Ear, Pen, and Hand.* New York: Academic Press.

Galaburda, A. M., & Kemper, T. L. (1979). Cytoarchitectonic abnormalities in developmental dyslexia: A case study. *Annals of Neurology, 6*, 94-100.

Garrett, M. F. (1975). The analysis of sentence production. In G. H. Bower (Ed.), *The psychology of learning and motivation. Advances in research and theory. Vol. 9* (pp. 133-177). New York: Academic Press.

Garrett, M. F. (1976). Syntactic processes in sentence production. In R. Wales & E. C. T. Walker (Eds.), *New approaches to language mechanisms.* Amsterdam: New Holland.

Garrett, M. F. (1980). Levels of processing in sentence production. In B. Butterworth (Ed.), *Language production. Vol 1* (pp. 177-220). London: Academic Press.

Geschwind, N. (1982). Why Orton was right. *Annals of Dyslexia, 32*, 13-30.

Glushko, R. J. (1979). The organization and activation of orthographic knowledge in reading aloud. *Journal of Experimental Psychology: Human Perception and Perfomance, 5*, 674-691.

Goodman, K. S. (1969). Analysis of oral reading miscues: Applied psycholinguistics. *Reading Research Quarterly, 5*, 9-30.

Goodman, K. S. (1973). Miscues: Windows on the reading process. In K. S. Goodman (Ed.), *Miscue analysis: Applications to reading instruction.* Urbana: ERIC Clearinghouse on Reading and Communication Skills, National Council of Teachers of English.

Gough, P. B. (1972). One second of reading. In J. F. Kavanagh & I. G. Mattingly (Eds.), *Language by ear and by eye. The relationships between speech and reading* (pp. 331-358). Cambridge: The MIT Press.

Graesser, A. C., Hoffman, N. L., & Clark, L. F. (1980). Structural components of reading time. *Journal of Verbal Learning and Verbal Behavior, 19*, 135-151.

Grice, H. P. (1967). William James Lectures. Harvard University. Published in part as 'Logic and conversation'. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics, Vol 3: Speech acts.* New York: Seminar Press.

Grosjean, F. (1980). Spoken word recognition processes and the gating paradigm. *Perception & Psychophysics, 28*, 267-283.

Guthrie, J. T. (1973). Reading comprehension and syntactic responses in good and poor readers. *Journal of Educational Psychology, 65*, 294-299.

Guthrie, J. T., & Goldberg, H. K. (1972). Visual sequential memory in reading disability. *Journal of Learning Disabilities, 5*, 41-46.

Heckelman, R. G. (1969). Neurological impress method of remedial reading. *Academic Therapy, 4*, 277-282.

Hockett, C. F. (1973). Where the tongue slips, there slip I. In V. A. Fromkin (Ed.), *Speech errors as linguistic evidence* (pp. 93-119). The Hague: Mouton.

Hoenkamp, E. (1980). *Spontaneous speech as a feedback process.* Internal report (80 FU 09), Department of Psychology, University of Nijmegen, The Netherlands.

Huey, E. B. (1908). *The psychology and pedagogy of reading.* Cambridge: MIT Press (reprint).

Just, M. A., & Carpenter, P. A. (1978). Inference processes during reading: Reflections from eye fixations. In J. W. Senders, D. F. Fisher & R. A. Monty (Eds.), *Eye movements and the higher psychological functions.* Hillsdale: Lawrence Erlbaum Associates.

Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review, 87*, 329-354.

Just, M. A., & Carpenter, P. A. (1987). *The psychology of reading and language comprehension.* Boston: Allyn and Bacon.

Kempen, G., & Huijbers, P. (1983). The lexicalization process in sentence production and naming: Indirect election of words. *Cognition, 14*, 185-209.

Kempff, H., Kerkman, H., & Kusters, D. (1979). *Some aspects of the elicitation of speech errors in Dutch.* Unpublished master's thesis. University of Nijmegen, The Netherlands.

Kintsch, W., & Dijk, T. A. van (1978). Toward a model of text comprehension and production. *Psychological Review, 85*, 363-394.

Klein, H. A., Klein, G. A., & Bertino, M. (1974). Utilization of context for word identification in children. *Journal of Experimental Child Psychology, 17*, 79-86.

Kolers, P. A. (1970). Three stages of reading. In H. Levin & J.P. Williams (Eds.), *Basic studies on reading* (pp. 90-118). New York: Basic Books.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*, 293-323.

Laver, J. D. M. (1973). The detection and correction of slips of the tongue. In V. A. Fromkin (Ed.), *Speech Errors as Linguistic Evidence* (pp. 132-143). The Hague: Mouton.

Laver, J. D. M. (1980). Monitoring systems in the neurolinguistic control of speech production. In V. A. Fromkin (Ed.), *Errors in linguistic performance. Slips of the tongue, ear, pen, and hand* (pp. 287-305). New York: Academic Press.

Lefton, L. A., Spragins, A. B., & Byrnes, J. (1973). English orthography: Relation to reading experience. *Bulletin of the Psychonomic Society, 2*, 281-282.

Leij, A. van der (1983). *Ernstige leesproblemen. Een onderzoek naar mogelijkheden tot differentiatie en behandeling* [Severe reading problems. Research of ways of differentiation and treatment]. Lisse: Swets & Zeitlinger.

Leij, A. van der (1985). Methodieken voor behandeling van ernstige leesproblemen [Methods of treatment of severe reading problems]. In A. van der Leij & L. M. Stevens

(Eds.), *Dyslexie. Verslag van het congres over dyslexie, woordblindheid, lees- en schrijfstoornissen gehouden in het Nederlands Congresgebouw te 's-Gravenhage op 18 en 19 juni 1985* (pp. 117-135). Lisse: Swets & Zeitlinger.

Lesgold, A. M., & Perfetti, C. A. (1978). How reading disabilities develop: Perspectives from a longitudinal study. In J. P. Das, R. Mulcahy & A. E. Wall (Eds.), *Theory and research in learning disability*. New York: Plenum.

Lesgold, A. M., Roth, S.F., Curtis, M. E. (1979). Foregrounding effects in discourse comprehension. *Journal of Verbal Learning and Verbal Behavior*, *18*, 291-308.

Leu, D. J. (1982). Oral reading error analysis: A critical review of research and application. *Reading Research Quarterly*, *17*, 420-437.

Levelt, W. J. M. (1983). Monitoring and self-repair in speech. *Cognition*, *14*, 41-104.

Levelt, W. J. M., & Kelter, S. (1982). Surface form and memory in question answering. *Cognitive Psychology*, *14*, 78-106.

Levelt, W. J. M., & Schriefers, H. (in press). *Issues of lexical access in language production.*

Liberman, I. Y., & Shankweiler, D. (1979). Speech, the alphabet, and teaching to read. In L. B. Resnick & P. A. Weaver (Eds.), *Theory and practice of early reading. Vol. 2.* Hillsdale: Erlbaum.

Lorenz, L., & Vockell, E. (1979). Using the neurological impress method with learning disabled readers. *Journal of Learning Disabilities*, *12*, 67-69.

Mackay, D. G. (1971). Stress pre-entry in motor systems. *American Journal of Psychology*, *84*, 35-51.

Mackay, D. G. (1972). The structure of words and syllables: Evidence from errors in speech. *Cognitive Psychology*, *3*, 210-227.

Marshall, J. C., & Newcombe, F. (1966). Syntactic and semantic errors in paralexia. *Neuropsychologia*, *4*, 169-176.

Marslen-Wilson, W. D. (1985). Speech shadowing and speech comprehension. *Speech Communication*, *4*, 55-73.

Marslen-Wilson, W. D. (in press). Parallel processing in spoken word-recognition. *Cognition*,

Marslen-Wilson, W. D., & Tyler, L. K. (1980). The temporal structure of spoken language understanding. *Cognition*, *8*, 1-71.

Marslen-Wilson, W. D., & Welsh, A. (1978). Processing interactions and lexical access during word recognition in continuous speech. *Cognitive Psychology*, *10*, 29-63.

McClelland, J. L., & Elman, J. L (1986). The TRACE model of speech perception. *Cognitive Psychology*, *18*, 1-86.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review*, *88*, 375-407.

Meringer, R. (1908). *Aus dem Leben der Sprache*. Berlin: V. Behr's Verlag.

Meringer, R., & Mayer, C. (1895). *Versprechen und verlesen, eine psychologisch-linguistische Studie* [Slips of the tongue and the eye, a psycholinguistic study]. Stuttgart: Göschense Verlagsbuchhandlung.

Merrill, E. C., Sperber, R. D., & McCauley, C. (1980). The effects of context on word identification in good and poor readers. *The Journal of Psychology*, *106*, 179-192.

Mitchell, D. C. (1982). *The process of reading. A cognitive analysis of fluent reading and learning to read.* Chichester: John Wiley & Sons.

Morton, J. (1969). Interaction of information in word recognition. *Psychological Review, 76*, 165-178.

Motley, M. T., & Baars, B. J. (1975a). *Laboratory induction of verbal slips: A new methodology for psycholinguistic research.* Paper presented to Western Speech Communication Association, Seattle.

Motley, M. T., & Baars, B. J. (1975b). Encoding sensitivities to phonological markedness and transitional probability: Evidence from spoonerisms. *Human Communication Research, 2*, 353-361.

Motley, M. T., & Baars, B. J. (1976). Semantic bias effects on the outcomes of verbal slips. *Cognition, 4*, 177-187.

Motley, M. T., & Baars, B. J. (1979). Effects of cognitive set upon laboratory induced verbal (Freudian) slips. *Journal of Speech and Hearing Research, 22*, 421-432.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*, 231-259.

Noordman, L. G. M. (1979). *Inferring from language.* Berlin: Springer-Verlag.

Noordman, L. G. M., Eling, P. A. T. M., & Thomassen, A. J. W. M. (1984). Een overzicht van het lezen als een psychologisch proces [A survey of reading as a psychological process]. In A. J. W. M. Thomassen, L. G. M. Noordman & P. A. T. M. Eling (Eds.), *Het leesproces* (pp. 1-25). Lisse: Swets & Zeitlinger.

Noordman, L. G. M., & Vonk, W. (1981). Lezen: het begrijpen van tekst [Reading: The comprehension of text]. *Nederlands Tijdschrift voor de Psychologie, 36*, 385-408.

Nooteboom, S. G. (1980). Speaking and unspeaking: Detection and correction of phonological and lexical errors in spontaneous speech. In V. A. Fromkin (Ed.), *Errors in linguistic performance. Slips of the tongue, ear, pen, and hand* (pp. 87-95). New York: Academic Press.

Oakan, R., Wiener, M., & Cromer, W. (1971). Identification, organization and reading comprehension for good and poor readers. *Journal of Educational Psychology, 62*, 71-78.

Olson, R. K., Kliegl, R., & Davidson, B. J. (1983). Dyslexic and normal children's tracking eye movements. *Journal of Experimental Psychology: Human Perception and Performance, 9*, 816-825.

Orton, S. T. (1925). Word-blindness in school children. *Archives of Neurology and Psychiatry, 14*, 581-615.

Orton, S. T. (1937). *Reading, writing, and speech problems in children.* New York: Norton.

Paap, K. R., Newsome, S., MacDonald, J. E., & Schvaneveldt, R. W. (1982). An activation-verification model for letter and word recognition: The word-superiority effect. *Psychological Review, 89*, 573-594.

Paris, S. G., & Myers, M. (1981). Comprehension monitoring, memory, and study strategies of good and poor readers. *Journal of Reading Behavior, 13*, 5-22.

Parkin, A. J. (1982). Phonological recoding in lexical decision: Effects of spelling-to-sound regularity depend on how regularity is defined. *Memory and Cognition, 10*, 43-53.

Parkin, A. J., & Underwood, G. (1983). Orthographic vs. phonological irregularity in lexical decision. *Memory and Cognition, 11*, 351-355.

Pavlidis, G. Th. (1981). Sequencing, eye movements and the early objective diagnosis of dyslexia. In G. Th. Pavlidis & T. R. Miles (Eds.), *Dyslexia research and its application to education* (pp. 99-163). Chichester: John Wiley & Sons.

Pavlidis, G. Th. (1986). The role of eye movements in the diagnosis of dyslexia. In G. Th. Pavilidis & D. F. Fisher (Eds.), *Dyslexia: Its neuropsychology and treatment* (pp. 97-110). Chichester: John Wiley & Sons.

Perfetti, C. A. (1977). Language comprehension and fast decoding: Some psycholinguistic prerequisites for skilled reading comprehension. In J. T. Guthrie (Ed.), *Cognition, curriculum and comprehension* (pp. 20-41). Hillsdale: Erlbaum.

Perfetti, C. A. (1985). *Reading Ability*. New York: Oxford University Press.

Perfetti, C. A., Finger, E., & Hogaboam, T. W. (1978). Sources of vocalization latency differences between skilled and less skilled young readers. *Journal of Educational Psychology, 70*, 730-739.

Perfetti, C. A., & Hogaboam, T. W. (1975). Relationship between single word decoding and reading comprehension skill. *Journal of Educational Psychology, 67*, 461-469.

Perfetti, C. A., & Lesgold, A. M. (1977). Discourse comprehension and sources of individual differences. In M. A. Just & P. A. Carpenter (Eds.), *Cognitive processes in comprehension* (pp. 141-183). Hillsdale: Erlbaum.

Perfetti, C. A., & Roth, S. (1981). Some of the interactive processes in reading and their role in reading skill. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 269-297). Hillsdale: Erlbaum.

Pflaum, S. W., & Bryan, T. H. (1980). Oral reading behaviors in the learning disabled. *The Journal of Educational Research*, 252-258.

Pirozzolo, F. J., & Rayner, K. (1978). Disorders of oculomotor scanning and graphic orientation in Develomental Gerstmann Syndrome. *Brain and Language, 5*, 119-126.

Rayner, K. (1986). Eye movements and the perceptual span: Evidence for dyslexic typology. In G. Th. Pavlidis & D. F. Fisher (Eds.), *Dyslexia: Its neuropsychology and treatment* (pp. 111-130). Chichester: John Wiley & Sons.

Reicher, G. M. (1969). Perceptual recognition as a function of meaningfulness of stimulus material. *Journal of Experimental Psychology, 81*, 274-280.

Rozin, P., & Gleitman, L. R. (1977). The structure and acquisition of reading II: The reading process and the acquisition of the alphabetic principle. In A. S. Reber & D. L. Scarborough (Eds.), *Toward a psychology of reading: Proceedings of the CUNY conference* (pp. 55-141). Hillsdale: Erlbaum.

Rubinstein, H., Lewis, S. S., & Rubinstein, M. A. (1971). Evidence for phonemic recoding in visual word recognition. *Journal of Verbal Learning and Verbal Behavior, 10*, 645-657.

Schvaneveldt, R., Ackerman, B. P., & Semlar, T. (1977). The effect of semantic context on children's word recognition. *Child Development, 48*, 612-616.

Schwartz, R. M., & Stanovich, K. E. (1981). Flexibility in the use of graphic and contextual information by good and poor readers. *Journal of Reading Behavior, 13*, 263-269.

Seidenberg, M. S. (1985). The time course of information activation and utilization in visual word recognition. In D. Besner, T. G. Waller & G. E. MacKinnon (Eds.), *Reading research. Advances in theory and practice. Vol. 5* (pp. 199-252). New York: Academic Press.

Shankweiler, D., & Crain, S. (1986). Language mechanisms and reading disorder: A modular approach. *Cognition, 24*, 139-168.

Shattuck-Hufnagel, S. (1979). Speech errors as evidence for a serial-ordering mechanism in sentence production. In W. E. Cooper & E. C. T. Walker (Eds.), *Sentence Processing: Psycholinguistic studies presented to Merrill Garrett.* (pp. 295-342). Hillsdale: Erlbaum.

Simpson, G. B., Lorsbach, T. C., & Whitehouse, D. (1983). Encoding and contextual components of word recognition in good and poor readers. *Journal of Experimental Child Psychology, 35*, 161-171.

Singer, M. H. (1980). The primacy of visual information in the analysis of letter strings. *Perception & Psychophysics, 27*, 153-162.

Spoehr, K. T., & Smith, E. E. (1973). The role of syllables in perceptual processing. *Cognitive Psychology, 5*, 71-89.

Spring, C. (1971). Perceptual speed in poor readers. *Journal of Educational Psychology, 62*, 492-500.

Stanley, G., Smith, G. A., & Howell, E. A. (1983). Eye movements and sequential tracking in dyslexic and control children. *British Journal of Psychology, 74*, 181-187.

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly, 16*, 32-71.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*, 360-407.

Stanovich, K. E., & Bauer, K. W. (1978). Experiments on the spelling-to-sound regularity effect in word recognition. *Memory and Cognition, 6*, 410-415.

Taft, M. (1979). Lexical access via an orthographic code: The Basic Orthographic Syllabic Structure (BOSS). *Journal of Verbal Learning and Verbal Behavior, 18*, 21-39.

Thibadeau, R., Just, M. A., & Carpenter, P. A. (1982). A model of the time course and content of reading. *Cognitive Science, 6*, 157-203.

Thompson, G. B. (1984). Self-corrections and the reading process: An evaluation of evidence. *Journal of Research in Reading, 7*, 53-61.

Vellutino, F. R. (1979). *Dyslexia: Theory and research.* Cambridge: The MIT Press.

Vellutino, F. R. (1980). Dyslexia. Perceptual deficiency or perceptual inefficiency. In J. F. Kavanagh & R. L. Venezky (Eds.), *Orthography, reading, and dyslexia* (pp. 251-270). Baltimore: University Park Press.

Vellutino, F. R., Steger, J. A., DeSetto, L, & Phillips, F. (1975). Immediate and delayed recognition of visual stimuli in poor and normal readers. *Journal of Experimental Child Psychology, 19*, 223-232.

Venezky, R. L. (1974). Theoretical and experimental bases for teaching reading. In T. A. Sebeok (Ed.), *Current trends in linguistics. Vol. 12* (pp. 2057-2100). The Hague: Mouton.

Vernon, M. D. (1971). *Reading and its difficulties.* Cambridge: Cambridge University Press.

Weber, R. M. (1970a). A linguistic analysis of first-grade reading errors. *Reading Research Quarterly*, *5*, 427-451.

Weber, R. M. (1970b). First-graders' use of grammatical context in reading. In H. Levin & J. P. Williams (Eds.), *Basic studies on reading* (pp. 147-163). New York: Basic Books.

Wells, R. (1951). Predicting slips of the tongue. *The Yale Scientific Magazine*, *26*, 9-30.

West, R. F., & Stanovich, K. E. (1978). Automatic contextual facilitation in readers of three ages. *Child Development*, *49*, 717-727.

Wijk, C. H. van (1987). *Speaking, writing, and sentence form: Three psycholinguistic studies.* Unpublished doctoral dissertation, University of Brabant.

Wixson, K. L. (1979). Miscue analysis: A critical review. *Journal of Reading Behavior*, *11*, 163-175.

Curriculum Vitae

Domien Kusters werd geboren te Heerlen op 23 maart 1953. In 1974 behaalde hij het diploma atheneum A, waarna hij Nederlandse Taal- en Letterkunde studeerde aan de Katholieke Universiteit Nijmegen. Deze studie, waarin het accent na het kandidaats-examen lag op psycholinguïstiek en computerlinguïstiek, sloot hij in 1979 af (c.l.) met als hoofdrichting moderne taalkunde.

Werkzaamheden:

augustus 1979 - maart 1982	leraar Nederlands aan het Bisschoppelijk College te Sittard.
februari 1981 - maart 1982	op part-time basis werkzaam bij het TOSCA project aan de afdeling Engelse Taal- en Letterkunde van de Katholieke Universiteit Nijmegen.
maart 1982 - maart 1986	aangesteld bij de Interfacultaire Werkgroep voor Taal- en Spraakgedrag te Nijmegen ten behoeve van het door Z.W.O. gesubsidieerde onderzoeksproject: "Zelfcorrecties bij hardop lezen".
augustus 1986 - heden	verbonden aan het Centrum voor Lexicale Informatie te Nijmegen.